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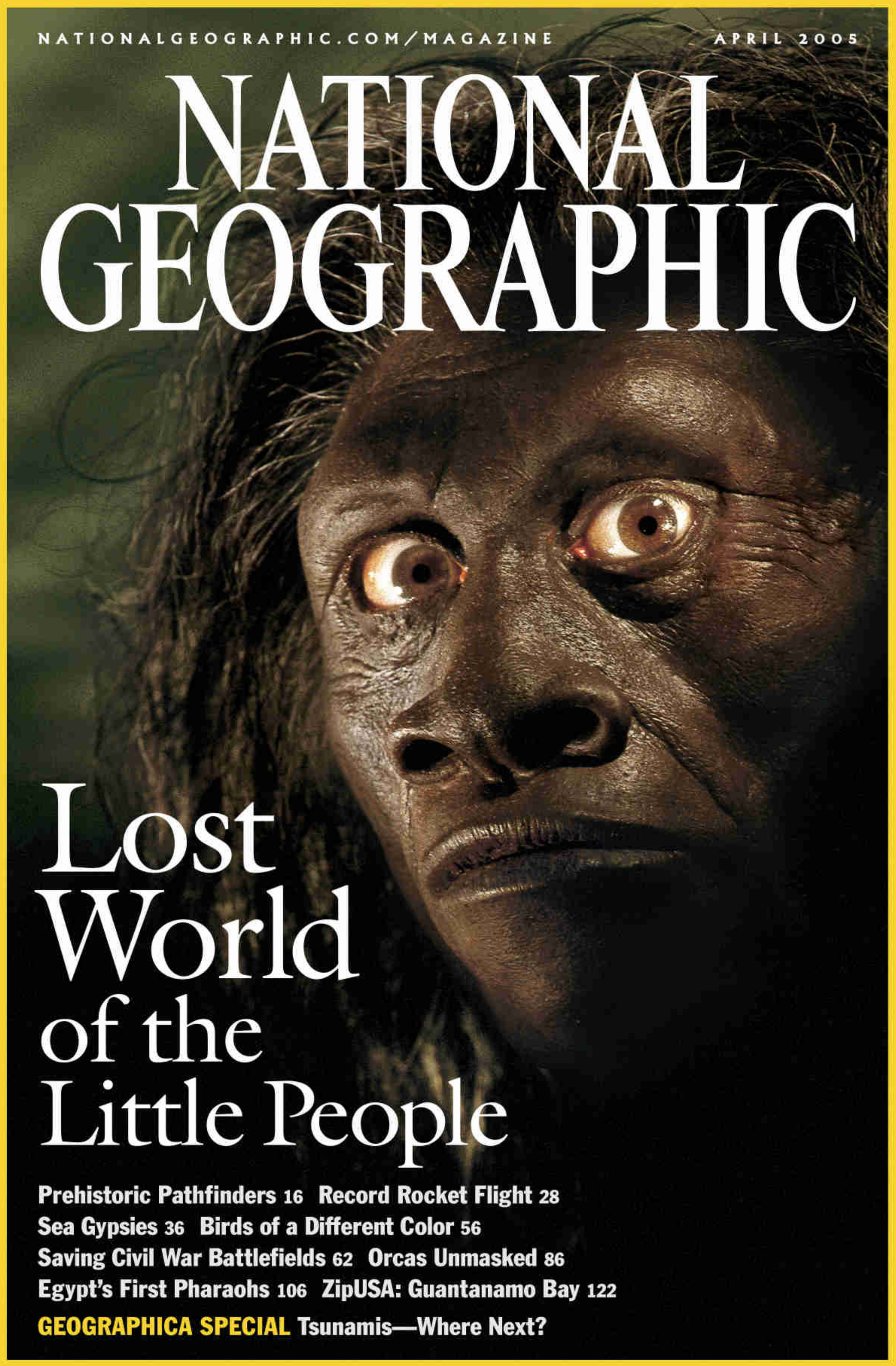
NATIONAL GEOGRAPHIC



Lost World of the Little People

SUPPLEMENT TO NATIONAL GEOGRAPHIC, APRIL 2005

Battles of the CIVIL WAR

Produced by National Geographic Maps for National Geographic Magazine

NATIONAL GEOGRAPHIC

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Washington, D.C., April 2005

► Step onto Civil War battlefields in a multimedia special with photographer Michael Melford and get on the front lines to save hallowed ground. Then zoom in on an interactive version of this map, download wallpaper, find a photo gallery, and speak out in our Civil War forum at **nationalgeographic.com/magazine/0504.**

A Nation Rips Itself Apart

Determined to preserve a way of life rooted in slavery, 11 southern states declared themselves the independent Confederate States of America early in 1861. President Lincoln asked for 75,000 militiamen to put down this "insurrection." Union strategy called for cutting the Confederacy off from markets and resources abroad and destroying its defenses at home. Southern leaders planned to make the cost of these efforts so great—in blood and treasure—that northern support for the war would collapse before the Union's death grip closed on the Confederacy. So began four bitter years that saw three million Americans take up arms against each other.

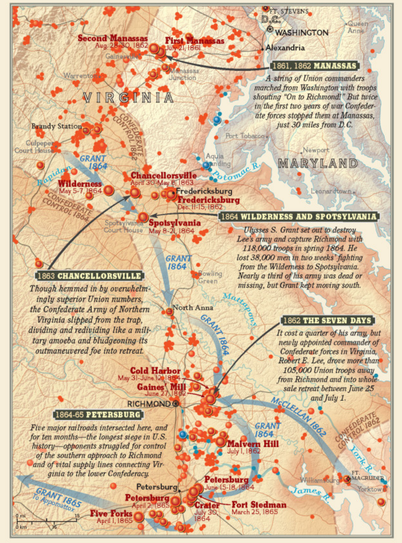
MAP LEGEND

Union state
Union slave state
Confederate state
Road
Railroad
Battle site impact on war
Decisive
Major
Limited
Significant naval involvement
Other battle site
Land
Naval
1862 VALLEY Major land campaign
1865 Union
Confederate
Major Union naval campaign
May 9, 1862 Captured by Union forces

The battles listed as historically significant were designated by the Civil War Sites Advisory Commission in its 1993 report to Congress. The report ranked battles by their impact on the war and made recommendations for preservation of the fields on which they were fought.

Battle for the Capitals

Just a hundred miles separated the Union capital of Washington from the Confederate capital at Richmond. So brutally contested was the terrain in between that soldiers in 1864 marched past the exposed remains of those who had fought in the Chancellorsville battle one year before.



Turning Points of the War

1862: NO EASY VICTORY

In spring the North seems unstoppable, seizing control of major rivers and railroad junctions in the west and launching a massive campaign against Richmond. Then Confederates begin to pummel larger Union forces in the Shenandoah Valley. In summer Southerners repulse the assault on their capital, then humiliate the North for a second time at Manassas and launch invasions of Maryland and Kentucky. Though they suffer bloody defeats at Antietam and Perryville, Confederate forces regroup and end the year by slaughtering Union foes at Fredericksburg.

1863: THE TIDE SHIFTS

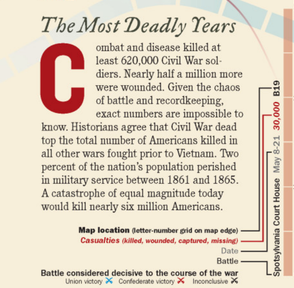
The year begins with southern troops ascendant in the east, defeating an assault on Charleston and savaging larger northern forces at Chancellorsville. But Union troops win victory at Stones River, then, in early July, other Union forces beat back a Confederate invasion of Pennsylvania at Gettysburg. On July 4 Vicksburg, Mississippi—the South's "invincible" city—falls to a besieging northern army, and all of the Mississippi River flows within Union control. In late summer Abraham Lincoln sends a letter to an old friend in Illinois: "Peace," he writes, "does not appear so distant as it did."

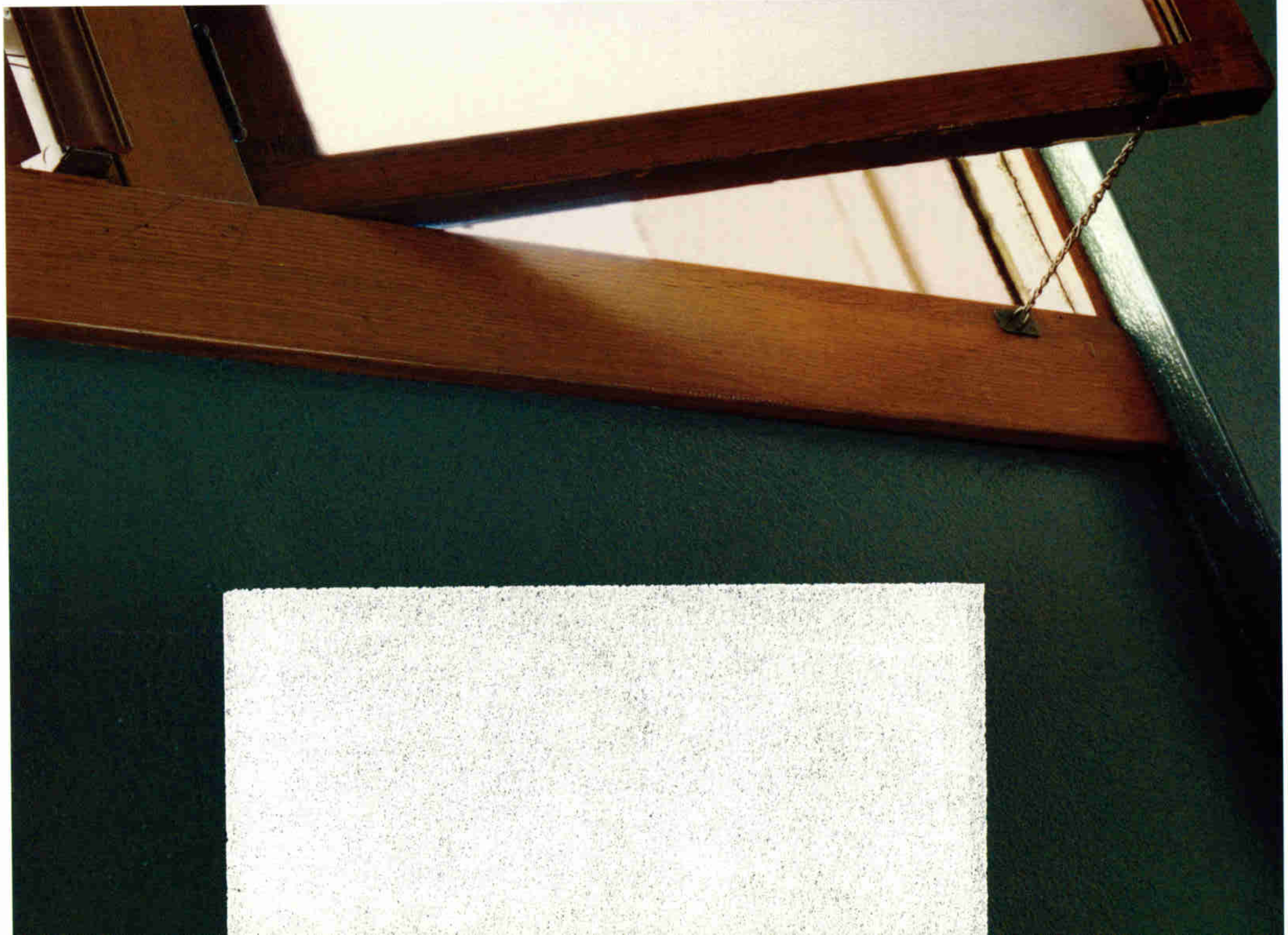
1864: THE BEGINNING OF THE END

Northern spirits plummet as Union forces on the Red River are routed and troops marching against Richmond suffer massive losses. Lincoln doubts he will win a second term, his opponents pledging to end the "failed" war. Then Union forces capture Atlanta, slashing the eastern Confederacy apart, and a jubilant North reelects Lincoln. Southern hopes crumble. Diarist Mary Chesnut records her despairing certainty: "We are going to be wiped off the face of the Earth." Though the war will drag on through early 1865, the ravaged Confederacy is in its death throes.

The Most Deadly Years

Combat and disease killed at least 620,000 Civil War soldiers. Nearly half a million more were wounded. Given the chaos of battle and recordkeeping, exact numbers are impossible to know. Historians agree that Civil War dead top the total number of Americans killed in all other wars fought prior to Vietnam. Two percent of the nation's population perished in military service between 1861 and 1865. A catastrophe of equal magnitude today would kill nearly six million Americans.





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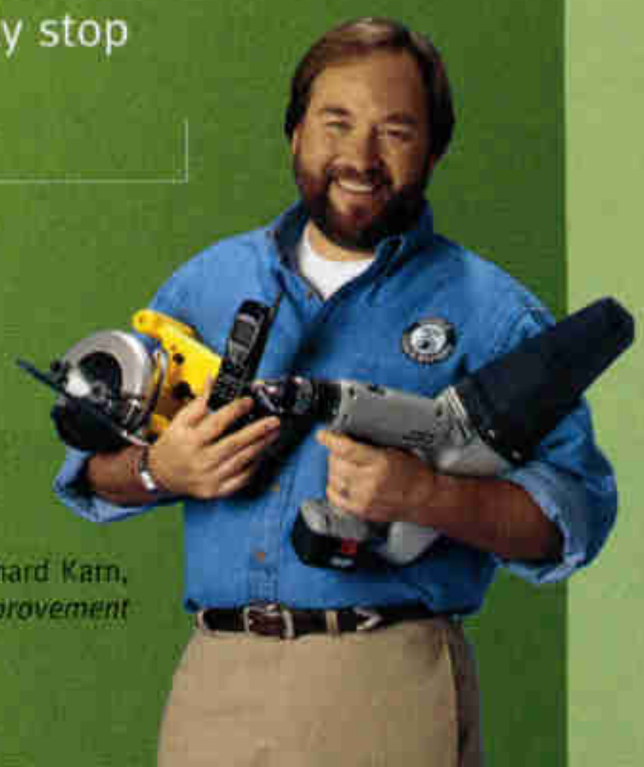
And it's easy to recycle your rechargeable batteries once they've worn out. You know – the ones in laptop computers, cell phones, PDAs, cordless power tools, camcorders and remote control toys. To find the nearest collection site, visit **www.rbrc.org**, call **1-800-8-BATTERY**, or simply stop by one of the listed national retailers. So do the green thing.

Recycle your rechargeable batteries.



RBRC Spokesperson Richard Karn,
"Al" from TV's *Home Improvement*

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Target

In Canada:
Bell Mobility
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Future Shop
The Home Depot
RadioShack
The Sony Store
TELUS Mobility

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JOANNE DAVIS, AFP/GETTY IMAGES

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DEPARTMENTS

THE COVER
An astonishing new species of human comes to light.
BY KENNETH GARRETT
ART BY JOHN GURCHE

Cover printed on recycled-content paper

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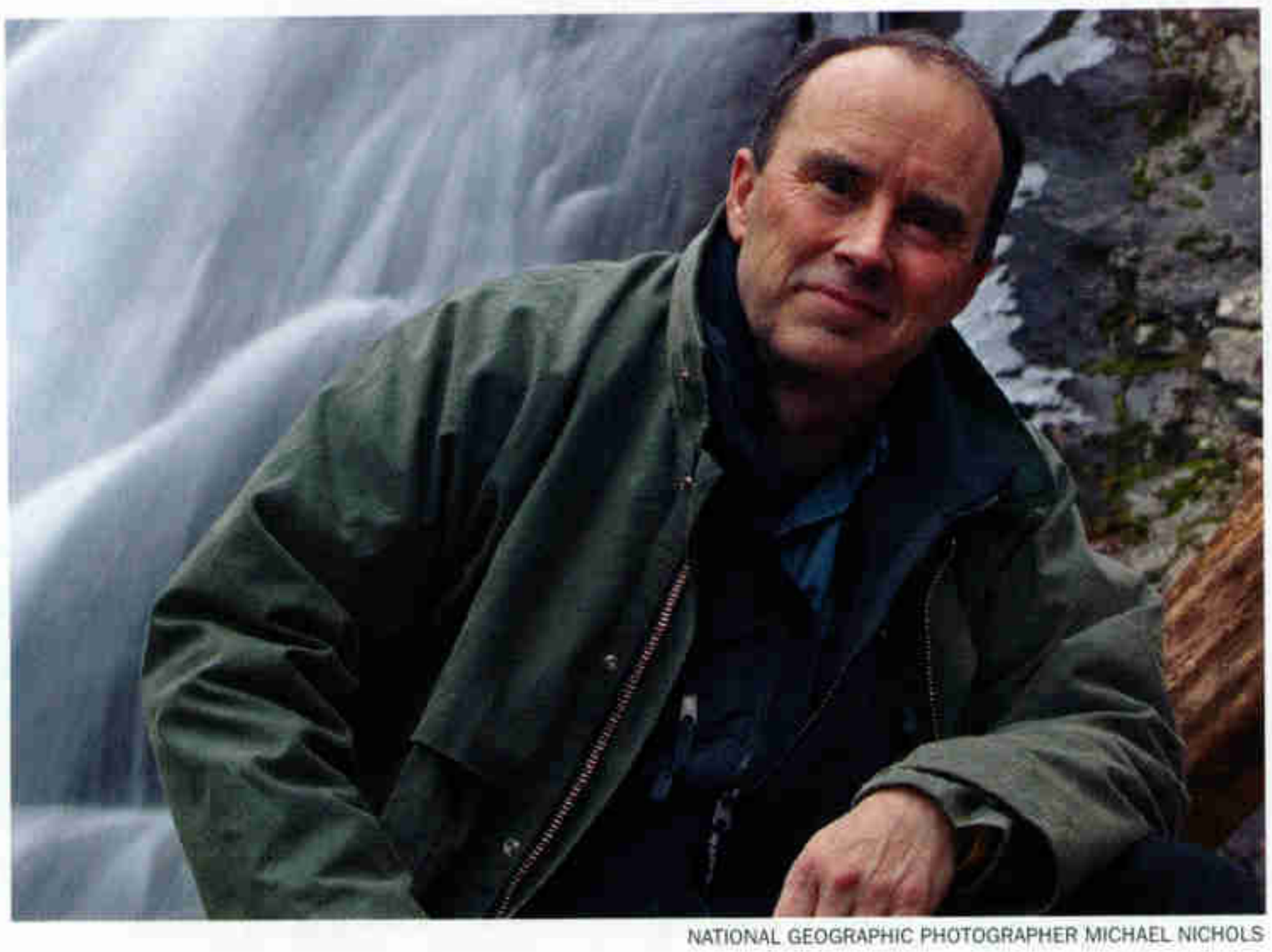
From the Editor



NATIONAL GEOGRAPHIC PHOTOGRAPHER MICHAEL NICHOLS

I'll never forget the first time my three-year-old daughter, Noel, and I stood on the shore of Hawai'i Volcanoes National Park and heard the hiss of red-hot lava pouring into the Pacific. It was a spectacular display of the power and majesty of nature. A thrilling first. I'll also never forget the first time I heard the thunder of an Alaska avalanche. That was a force of nature too, and it nearly buried me on a photography expedition in the Chugach Mountains. It was a terrifying first.

That's the way it is with firsts. In some way they all carry a sense of awe; in the very best instances, they are about new challenges and possibilities.

Which is exactly how I feel about another first, perhaps my most memorable in a 20-year-long career at National Geographic: my first letter to you as Editor of this magazine.

As Editor, I like to think our magazine is full of firsts, and the current issue holds a compelling example. This month you'll read about the discovery of a new human species, roughly three feet tall, that lived as recently as 13,000 years ago. It's been called one of the most outstanding discoveries in paleoanthropology in half a century, and I'm proud our Committee for Research and Exploration is an official sponsor of the work.

I could not ask for a better story to kick off my editorship than this—a story, in short, about beginnings.

OnScreen & Online

NATIONAL GEOGRAPHIC CHANNEL

MONDAY, APRIL 11, 8 P.M. ET/PT

Sturgis: Hell on Wheels

America's wildest carnival of humans and machines roars to life in the Black Hills of South Dakota when bikers by the thousands come calling for the 64th annual Sturgis Motorcycle Rally. See the town transformed by a week of chrome-flashing parades, a rubber-burning contest, tattoos, and noise—lots of noise. Join the film crew for a rousing hill ride, and feel that biker's high.

SUNDAYS AT 8 P.M. ET/PT

EXPLORER

Experience the world at its most dramatic. National Geographic Channel's acclaimed documentary series *Explorer,* with host Lisa Ling, brings viewers to the heart of today's most vital stories. Tune in to learn about efforts to find humanity's common ancestor and why elephants in Asia and Africa are killing humans in greater numbers.

WEDNESDAYS, APRIL 20 & 27, 9 P.M. ET/PT ON PBS

Strange Days on Planet Earth

Could a bird's eating of a non-native plant in Hawaii (below) trigger landslides? Why have hordes of howler monkeys and ants run rampant on man-made islands in Venezuela? With actor Edward Norton as host, this new series investigates the fragile connections that help keep the Earth's environment in balance.

Find out what's on and how to get the Channel in your area at *nationalgeographic.com/channel.* Programming information is accurate at press time. Consult local listings.

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SWEEPSTAKES **Win an Australian adventure** with a National Geographic photographer. You and a friend could spend two weeks down under and shoot with photo pro Annie Griffiths Belt. ■ **ENTER TODAY** and find official rules at ***nationalgeographic.com/travelaustralia.***

RUTAN FLIGHT **Experience** a 360-degree view of the spaceship's cockpit. ■ **CIVIL WAR BATTLEFIELDS** Take a multimedia tour through the Civil War's most influential battlefields with photographer Michael Melford, and join our forum on preserving these historic sites. ***nationalgeographic.com/magazine/0504***

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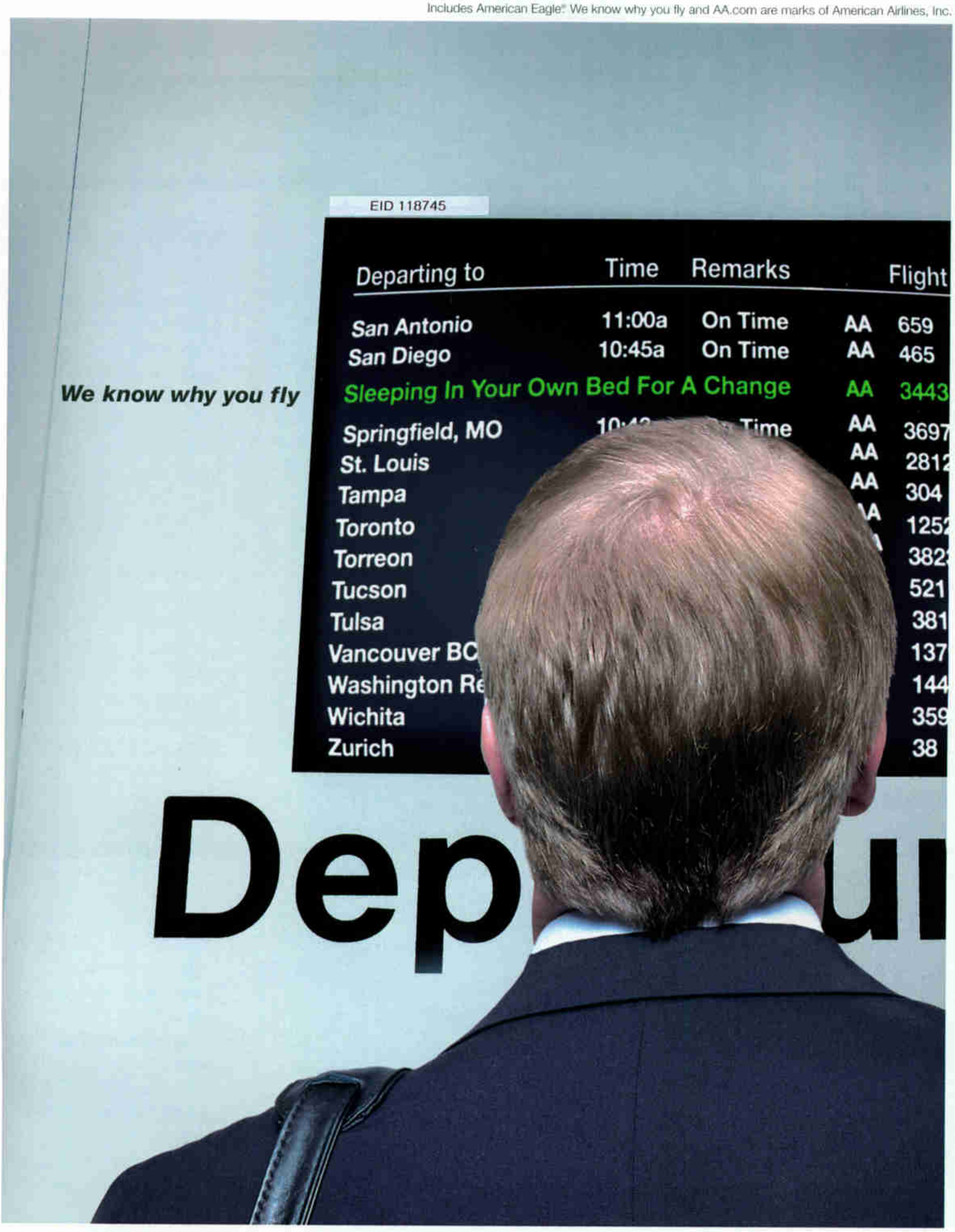
CLOCKWISE FROM TOP LEFT: ED KASHI, CORBIS; FRANS LANTING, MINDEN PICTURES; DAVID DOUBILET

Includes American Eagle®. We know why you fly and AA.com are marks of American Airlines, Inc.



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Behind the Scenes

TELEVISION

Strange Days

It was while filming the National Geographic Television & Film series *Shape of Life* four years ago that executive producer Mark Shelley first noticed the change. "I'd never heard such a large cry from scientists that something significant was happening with the environment on a global scale," he says. This groundswell of concern required a call to action as well as a different way of looking at the world. Using an approach called Earth system science, many scientists are seeing that seemingly distant phenomena could be, in fact, connected. "You can't explain the environment in sound bites anymore," Shelley says. *National Geographic's Strange Days on Planet Earth*, premiering on PBS on April 20 and 27 at 9 p.m. ET/PT, probes some of the mysteries—both big and small—plaguing our environment.

Invaders Spreading disease and destruction across the world, how do invasive species bite into livelihoods? Learn more about alien invasions on April 20.

One Degree Factor Could dry African lake beds be connected to childhood asthma in Trinidad? See some of the effects of climate change on April 20.

Predators What lessons were learned in Yellowstone when the park cut its wolf population? Gain a new appreciation for predators on April 27.

Troubled Waters Is coastal runoff increasing sea star outbreaks along Australia's Great Barrier Reef? Check in on the world's water on April 27.

RADIO

Ravi Birthday to You

George Harrison of the Beatles once celebrated him as the "godfather of world music." This month Ravi Shankar, legendary sitarist and composer, is celebrating too—his 85th birthday is on April 7. National Public Radio's Susan Stamberg visited with Shankar at his New Delhi arts center to reflect on his 75-year career. Their musical journey, part of the NPR/National Geographic monthly *Radio Expeditions* series, airs April 7 on NPR's *Morning Edition*.

KILLER WHALES (PAGE 86)

Get More

To learn more about a subject covered in this issue, try these National Geographic Society products and services. Call 1-888-225-5647 or log on to nationalgeographic.com *for more information.* ■ ***Killer Whales: Wolves of the Sea*** takes a video journey around the globe to see orcas hunt their prey ($19.95). ■ ***Whales of the World*** on your wall? Learn about 17 different whales on this 31-by-23-inch illustrated poster. Includes information on whales' size, feeding patterns, and more ($10.99).

Calendar

MARCH

"Tutankhamun and the Golden Age of the Pharaohs" exhibit. Tickets on sale for the June 16 opening at the Los Angeles County Museum of Art. See more than 130 ancient royal artifacts on the first stop of the exhibit's four-city tour. Call 1-877-TUT-TKTS or go to *kingtut.org*.

APRIL

6 "Alone Against the Sea" lecture. Adventurer Jon Bowermaster recounts some memorable expeditions, including his ongoing kayak trip around the world. National Geographic, Washington, D.C.

12 Photographer Frans Lanting presents a program about the world's jungles at the Field Museum's James Simpson Theatre in Chicago. Call 312-665-7400 for tickets.

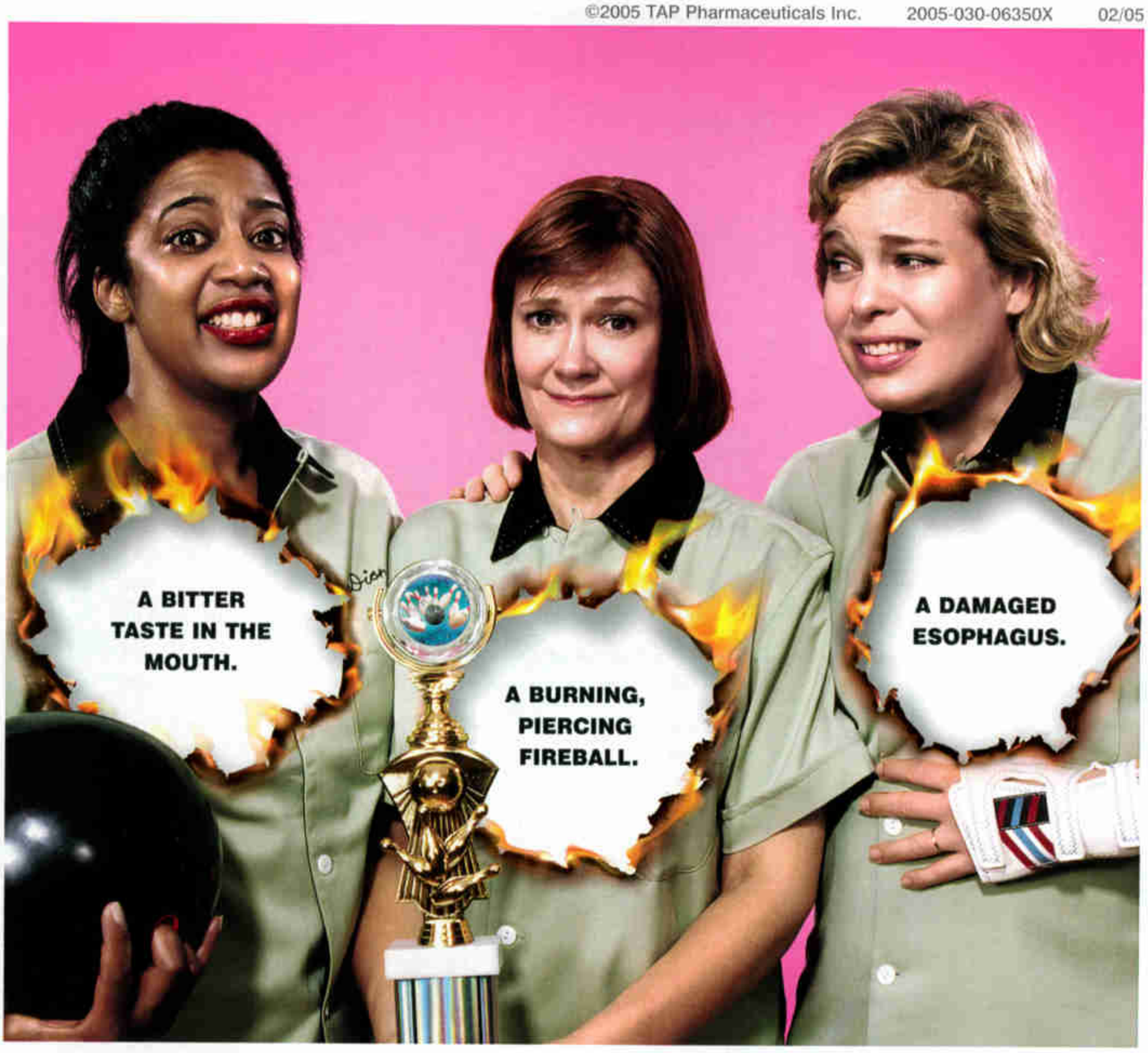
13 "The Cheeses of France" lecture. Cheese expert Steve Jenkins guides a tasting of France's most distinctive cheeses. National Geographic, Washington, D.C.

14 "Chimpanzees, Tools, and Termites" lecture. Elizabeth Lonsdorf speaks about her work with primates at the State Theatre in Minneapolis. For tickets, call 612-673-0404.

15 "Making Good Noise" concert. Grammy Award winner Tom Chapin performs his family-friendly music. National Geographic, Washington, D.C.

Calendar dates are accurate at press time; please go to *nationalgeographic.com* or call *1-800-NGS-LINE (647-5463) for more* information.

CENTER, FROM LEFT: CDC/PHIL, CORBIS; SEA STUDIOS FOUNDATION; JOEL SARTORE; DAVID DOUBILET. BOTTOM LEFT: VINCENT JAMES LIMONGELLI



Acid reflux disease can affect people differently. Some feel a burn rising from their stomach, some have difficulty sleeping, and others have a recurring sore throat or have trouble swallowing. Fortunately, there's Prevacid.® It can be taken in many forms—one that's a pill, one you can drink, and one that disintegrates in your mouth—to help treat heartburn and many other kinds of symptoms related to acid reflux disease in many kinds of people. Maybe it's time to see if it can help yours. So ask your doctor if there's a Prevacid that's right for you.

Put it to your acid test.

For a FREE trial certificate, call 1-888-3PREVACID or visit prevacid.com today.

If you suffer from persistent heartburn two or more days a week, despite treatment and diet changes, it may be acid reflux disease (ARD). Heartburn is the most common symptom of ARD. Prevacid Capsules, Prevacid for Oral Suspension, and Prevacid® SoluTab™ (lansoprazole) Orally Disintegrating Tablets are used to treat ARD. Individual results may vary. Prescription Prevacid has a low occurrence of side effects such as diarrhea, abdominal pain, and nausea. Symptom relief does not rule out serious stomach conditions. Please see adjacent brief summary of important information and talk to your doctor.

Brief Summary of Prescribing Information
(Nos. 1541, 1543, 1544, 3046, 7309, 7311)
03-5366-R24-Brf. Rev. July, 2004

PREVACID® (lansoprazole) Delayed-Release Capsules

PREVACID® (lansoprazole) For Delayed-Release Oral Suspension

PREVACID® SoluTab™ (lansoprazole) Delayed-Release Orally Disintegrating Tablets

Rx only

PREVACID Delayed-Release Capsules, PREVACID SoluTab Delayed-Release Orally Disintegrating Tablets and PREVACID For Delayed-Release Oral Suspension are indicated for:

Short-Term Treatment (4 weeks) of Active Duodenal Ulcer

***H. pylori* Eradication to Reduce the Risk of Duodenal Ulcer Recurrence**
Triple Therapy: PREVACID/amoxicillin/clarithromycin
Dual Therapy: PREVACID/amoxicillin
Who are either allergic or intolerant to clarithromycin or in whom resistance to clarithromycin is known or suspected.

Maintenance of Healed Duodenal Ulcers
Controlled studies do not extend beyond 12 months.

Short-Term Treatment (up to 8 weeks) of Active Benign Gastric Ulcer

Healing of NSAID-Associated Gastric Ulcer
In patients who continue NSAID use. Controlled studies did not extend beyond 8 weeks.

Risk Reduction of NSAID-Associated Gastric Ulcer
In patients with a history of a documented gastric ulcer who require the use of an NSAID. Controlled studies did not extend beyond 12 weeks.

Gastroesophageal Reflux Disease (GERD)
Short-Term Treatment of Symptomatic GERD
Short-Term Treatment (up to 8 weeks) of Erosive Esophagitis
For patients who do not heal with PREVACID for 8 weeks (5-10%), it may be helpful to give an additional 8 weeks of treatment. If there is a recurrence of erosive esophagitis an additional 8-week course of PREVACID may be considered.

Maintenance of Healing of Erosive Esophagitis
Controlled studies did not extend beyond 12 months.

Pathological Hypersecretory Conditions Including Zollinger-Ellison Syndrome

CONTRAINDICATIONS
PREVACID is contraindicated in patients with known hypersensitivity to any component of the formulation of PREVACID.

Amoxicillin is contraindicated in patients with a known hypersensitivity to any penicillin.

Clarithromycin is contraindicated in patients with a known hypersensitivity to clarithromycin, erythromycin, and any of the macrolide antibiotics.

Concomitant administration of clarithromycin with cisapride, pimozide, astemizole, or terfenadine is contraindicated. There have been post-marketing reports of drug interactions when clarithromycin and/or erythromycin are co-administered with cisapride, pimozide, astemizole, or terfenadine resulting in cardiac arrhythmias (QT prolongation, ventricular tachycardia, ventricular fibrillation, and torsades de pointes) most likely due to inhibition of metabolism of these drugs by erythromycin and clarithromycin. Fatalities have been reported.

(Please refer to full prescribing information for amoxicillin and clarithromycin before prescribing.)

WARNINGS
CLARITHROMYCIN SHOULD NOT BE USED IN PREGNANT WOMEN EXCEPT IN CLINICAL CIRCUMSTANCES WHERE NO ALTERNATIVE THERAPY IS APPROPRIATE. IF PREGNANCY OCCURS WHILE TAKING CLARITHROMYCIN, THE PATIENT SHOULD BE APPRISED OF THE POTENTIAL HAZARD TO THE FETUS. (SEE **WARNINGS** IN PRESCRIBING INFORMATION FOR CLARITHROMYCIN.)

Pseudomembranous colitis has been reported with nearly all antibacterial agents, including clarithromycin and amoxicillin, and may range in severity from mild to life threatening. Therefore, it is important to consider this diagnosis in patients who present with diarrhea subsequent to the administration of antibacterial agents.

Treatment with antibacterial agents alters the normal flora of the colon and may permit overgrowth of clostridia. Studies indicate that a toxin produced by *Clostridium difficile* is a primary cause of "antibiotic-associated colitis."

After the diagnosis of pseudomembranous colitis has been established, therapeutic measures should be initiated. Mild cases of pseudomembranous colitis usually respond to discontinuation of the drug alone. In moderate to severe cases, consideration should be given to management with fluids and electrolytes, protein supplementation, and treatment with an antibacterial drug clinically effective against *Clostridium difficile* colitis.

Serious and occasionally fatal hypersensitivity (anaphylactic) reactions have been reported in patients on penicillin therapy. These reactions are more apt to occur in individuals with a history of penicillin hypersensitivity and/or a history of sensitivity to multiple allergens.

There have been well-documented reports of individuals with a history of penicillin hypersensitivity reactions who have experienced severe hypersensitivity reactions when treated with a cephalosporin. Before initiating therapy with any penicillin, careful inquiry should be made concerning previous hypersensitivity reactions to penicillins, cephalosporins, and other allergens. If an allergic reaction occurs, amoxicillin should be discontinued and the appropriate therapy instituted.

SERIOUS ANAPHYLACTIC REACTIONS REQUIRE IMMEDIATE EMERGENCY TREATMENT WITH EPINEPHRINE, OXYGEN, INTRAVENOUS STEROIDS, AND AIRWAY MANAGEMENT, INCLUDING INTUBATION, SHOULD ALSO BE ADMINISTERED AS INDICATED.

PRECAUTIONS
General
Symptomatic response to therapy with lansoprazole does not preclude the presence of gastric malignancy.

Information for Patients
PREVACID is available as a capsule, orally disintegrating tablet and oral suspension, and is available in 15 mg and 30 mg strengths. Directions for use specific to the route and available methods of administration for each of these dosage forms is presented below. PREVACID should be taken before eating. PREVACID products SHOULD NOT BE CRUSHED OR CHEWED.

Phenylketonurics: Contains Phenylalanine 2.5 mg per 15 mg Tablet and 5.1 mg per 30 mg Tablet.

Administration Options

1. *PREVACID Delayed-Release Capsules*

PREVACID Delayed-Release Capsules should be swallowed whole.

Alternatively, for patients who have difficulty swallowing capsules, PREVACID Delayed-Release Capsules can be opened and administered as follows:
- Open capsule.
- Sprinkle intact granules on one tablespoon of either applesauce, ENSURE® pudding, cottage cheese, yogurt or strained pears.
- Swallow immediately.

PREVACID Delayed-Release Capsules may also be emptied into a small volume of either apple juice, orange juice or tomato juice and administered as follows:
- Open capsule.
- Sprinkle intact granules into a small volume of either apple juice, orange juice or tomato juice (60 mL – approximately 2 ounces).
- Mix briefly.
- Swallow immediately.
- To ensure complete delivery of the dose, the glass should be rinsed with two or more volumes of juice and the contents swallowed immediately.

USE IN OTHER FOODS AND LIQUIDS HAS NOT BEEN STUDIED CLINICALLY AND IS THEREFORE NOT RECOMMENDED.

2. *PREVACID SoluTab Delayed-Release Orally Disintegrating Tablets*

PREVACID SoluTab should not be chewed. Place the tablet on the tongue and allow it to disintegrate, with or without water, until the particles can be swallowed. The tablet typically disintegrates in less than 1 minute.

Alternatively, for children or other patients who have difficulty swallowing tablets, PREVACID SoluTab can be delivered in two different ways.

PREVACID SoluTab – Oral Syringe

For administration via oral syringe, PREVACID SoluTab can be administered as follows:
- Place a 15 mg tablet in oral syringe and draw up approximately 4 mL of water, or place a 30 mg tablet in oral syringe and draw up approximately 10 mL of water.
- Shake gently to allow for a quick dispersal.
- After the tablet has dispersed, administer the contents within 15 minutes.
- Refill the syringe with approximately 2 mL (5 mL for the 30 mg tablet) of water, shake gently, and administer any remaining contents.

PREVACID SoluTab – Nasogastric Tube Administration (≥ 8 French)
For administration via a nasogastric tube, PREVACID SoluTab can be administered as follows:
- Place a 15 mg tablet in a syringe and draw up 4 mL of water, or place a 30 mg tablet in a syringe and draw up 10 mL of water.
- Shake gently to allow for a quick dispersal.
- After the tablet has dispersed, inject through the nasogastric tube into the stomach within 15 minutes.
- Refill the syringe with approximately 5 mL of water, shake gently, and flush the nasogastric tube.

3. *PREVACID for Delayed-Release Oral Suspension*

PREVACID for Delayed-Release Oral Suspension should be administered as follows:
- Open packet.
- To prepare a dose, empty the packet contents into a container containing 2 tablespoons of **WATER**. DO NOT USE OTHER LIQUIDS OR FOODS.
- Stir well, and drink immediately.
- If any material remains after drinking, add more water, stir, and drink immediately.
- **This product should not be given through enteral administration tubes.**

Drug Interactions
Lansoprazole is metabolized through the cytochrome P_{450} system, specifically through the CYP3A and CYP2C19 isozymes. Studies have shown that lansoprazole does not have clinically significant interactions with other drugs metabolized by the cytochrome P_{450} system, such as warfarin, antipyrine, indomethacin, ibuprofen, phenytoin, propranolol, prednisone, diazepam, or clarithromycin in healthy subjects. These compounds are metabolized through various cytochrome P_{450} isozymes including CYP1A2, CYP2C9, CYP2C19, CYP2D6, and CYP3A. When lansoprazole was administered concomitantly with theophylline (CYP1A2, CYP3A), a minor increase (10%) in the clearance of theophylline was seen. Because of the small magnitude and the direction of the effect on theophylline clearance, this interaction is unlikely to be of clinical concern. Nonetheless, individual patients may require additional titration of their theophylline dosage when lansoprazole is started or stopped to ensure clinically effective blood levels.

In a study of healthy subjects neither the pharmacokinetics of warfarin enantiomers nor prothrombin time were affected following single or multiple 60 mg doses of lansoprazole. However, there have been reports of increased International Normalized Ratio (INR) and prothrombin time in patients receiving proton pump inhibitors, including lansoprazole, and warfarin concomitantly. Increases in INR and prothrombin time may lead to abnormal bleeding and even death. Patients treated with proton pump inhibitors and warfarin concomitantly may need to be monitored for increases in INR and prothrombin time.

Lansoprazole has also been shown to have no clinically significant interaction with amoxicillin.

In a single-dose crossover study examining lansoprazole 30 mg and omeprazole 20 mg each administered alone and concomitantly with sucralfate 1 gram, absorption of the proton pump inhibitors was delayed and their bioavailability was reduced by 17% and 16%, respectively, when administered concomitantly with sucralfate. Therefore, proton pump inhibitors should be taken at least 30 minutes prior to sucralfate. In clinical trials, antacids were administered concomitantly with PREVACID Delayed-Release Capsules; this did not interfere with its effect.

Lansoprazole causes a profound and long-lasting inhibition of gastric acid secretion; therefore, it is theoretically possible that lansoprazole may interfere with the absorption of drugs where gastric pH is an important determinant of bioavailability (e.g., ketoconazole, ampicillin esters, iron salts, digoxin).

Carcinogenesis, Mutagenesis, Impairment of Fertility
In two 24-month carcinogenicity studies, Sprague-Dawley rats were treated orally with doses of 5 to 150 mg/kg/day, about 1 to 40 times the exposure on a body surface (mg/m^2) basis, of a 50-kg person of average height (1.46 m^2 body surface area) given the recommended human dose of 30 mg/day (22.2 mg/m^2). Lansoprazole produced dose-related gastric enterochromaffin-like (ECL) cell hyperplasia and ECL cell carcinoids in both male and female rats. It also increased the incidence of intestinal metaplasia of the gastric epithelium in both sexes. In male rats, lansoprazole produced a dose-related increase of testicular interstitial cell adenomas. The incidence of these adenomas in rats receiving doses of 15 to 150 mg/kg/day (4 to 40 times the recommended human dose based on body surface area) exceeded the low background incidence (range = 1.4 to 10%) for this strain of rat. Testicular interstitial cell adenoma also occurred in 1 of 30 rats treated with 50 mg/kg/day (13 times the recommended human dose based on body surface area) in a 1-year toxicity study.

In a 24-month carcinogenicity study, CD-1 mice were treated orally with doses of 15 to 600 mg/kg/day, 2 to 80 times the recommended human dose based on body surface area. Lansoprazole produced a dose-related increased incidence of gastric ECL cell hyperplasia. It also produced an increased incidence of liver tumors (hepatocellular adenoma plus carcinoma). The tumor incidences in male mice treated with 300 and 600 mg/kg/day (40 to 80 times the recommended human dose based on body surface area) and female mice treated with 150 to 600 mg/kg/day (20 to 80 times the recommended human dose based on body surface area) exceeded the ranges of background incidences in historical controls for this strain of mice. Lansoprazole treatment produced adenoma of rete testis in male mice receiving 75 to 600 mg/kg/day (10 to 80 times the recommended human dose based on body surface area).

Lansoprazole was not genotoxic in the Ames test, the *ex vivo* rat hepatocyte unscheduled DNA synthesis (UDS) test, the *in vivo* mouse micronucleus test or the rat bone marrow cell chromosomal aberration test. It was positive in *in vitro* human lymphocyte chromosomal aberration assays.

Lansoprazole at oral doses up to 150 mg/kg/day (40 times the recommended human dose based on body surface area) was found to have no effect on fertility and reproductive performance of male and female rats.

Pregnancy: Teratogenic Effects.
Pregnancy Category B

Lansoprazole
Teratology studies have been performed in pregnant rats at oral doses up to 150 mg/kg/day (40 times the recommended human dose based on body surface area) and pregnant rabbits at oral doses up to 30 mg/kg/day (16 times the recommended human dose based on body surface area) and have revealed no evidence of impaired fertility or harm to the fetus due to lansoprazole.

There are, however, no adequate or well-controlled studies in pregnant women. Because animal reproduction studies are not always predictive of human response, this drug should be used during pregnancy only if clearly needed.

Pregnancy Category C
Clarithromycin
See **WARNINGS** (above) and full prescribing information for clarithromycin before using in pregnant women.

Nursing Mothers
Lansoprazole or its metabolites are excreted in the milk of rats. It is not known whether lansoprazole is excreted in human milk. Because many drugs are excreted in human milk, because of the potential for serious adverse reactions in nursing infants from lansoprazole, and because of the potential for tumorigenicity shown for lansoprazole in rat carcinogenicity studies, a decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother.

Pediatric Use
The safety and effectiveness of PREVACID have been established in pediatric patients 1 to 17 years of age for short-term treatment of symptomatic GERD and erosive esophagitis. Use of PREVACID in this population is supported by evidence from adequate and well-controlled studies of PREVACID in adults with additional clinical, pharmacokinetic, and pharmacodynamic studies performed in pediatric patients. The adverse events profile in pediatric patients is similar to that of adults. There were no adverse events reported in U.S. clinical studies that were not previously observed in adults. The safety and effectiveness of PREVACID in patients <1 year of age have not been established.

1 to 11 years of age
The pediatric safety of PREVACID Delayed-Release Capsules has been assessed in 66 pediatric patients aged 1 to 11 years of age. Of the 66 patients with GERD 85% (56/66) took PREVACID for 8 weeks and 15% (10/66) took it for 12 weeks.

The most frequently reported (2 or more patients) treatment-related adverse events in patients 1 to 11 years of age (N=66) were constipation (5%) and headache (3%).

12 to 17 years of age
The safety of PREVACID Delayed-Release Capsules has been assessed in these 87 adolescent patients. Of the 87 adolescent patients with GERD, 6% (5/87) took PREVACID for <6 weeks, 93% (81/87) for 6-10 weeks, and 1% (1/87) for >10 weeks.

The most frequently reported (at least 3%) treatment-related adverse events in these patients were headache (7%), abdominal pain (5%), nausea (3%) and dizziness (3%). Treatment-related dizziness, reported in this package insert as occurring in <1% of adult patients, was reported in this study by 3 adolescent patients with nonerosive GERD, who had dizziness concurrently with other events (such as migraine, dyspnea, and vomiting).

Use in Women
Over 4,000 women were treated with lansoprazole. Ulcer healing rates in females were similar to those in males. The incidence rates of adverse events were also similar to those seen in males.

Use in Geriatric Patients
Ulcer healing rates in elderly patients are similar to those in a younger age group. The incidence rates of adverse events and laboratory test abnormalities are also similar to those seen in younger patients. For elderly patients, dosage and administration of lansoprazole need not be altered for a particular indication.

ADVERSE REACTIONS
Clinical
Worldwide, over 10,000 patients have been treated with lansoprazole in Phase 2-3 clinical trials involving various dosages and durations of treatment. The adverse reaction profiles for PREVACID Delayed-Release Capsules and PREVACID for Delayed-Release Oral Suspension are similar. In general, lansoprazole treatment has been well-tolerated in both short-term and long-term trials.

The following adverse events were reported by the treating physician to have a possible or probable relationship to drug in 1% or more of PREVACID-treated patients and occurred at a greater rate in PREVACID-treated patients than placebo-treated patients:

Incidence of Possibly or Probably Treatment-Related Adverse Events in Short-Term, Placebo-Controlled Studies

Body System/Adverse Event	PREVACID (N= 2768) %	Placebo (N= 1023) %
Body as a Whole		
Abdominal Pain	2.1	1.2
Digestive System		
Constipation	1.0	0.4
Diarrhea	3.8	2.3
Nausea	1.3	1.2

Headache was also seen at greater than 1% incidence but was more common on placebo. The incidence of diarrhea was similar between patients who received placebo and patients who received lansoprazole 15 mg and 30 mg, but higher in the patients who received lansoprazole 60 mg (2.9%, 1.4%, 4.2%, and 7.4%, respectively).

The most commonly reported possibly or probably treatment-related adverse event during maintenance therapy was diarrhea.

In the risk reduction study of PREVACID for NSAID-associated gastric ulcers, the incidence of diarrhea for patients treated with PREVACID was 5%, misoprostol 22%, and placebo 3%.

Additional adverse experiences occurring in <1% of patients or subjects in domestic trials are shown below. Refer to **Postmarketing** for adverse reactions occurring since the drug was marketed.

Body as a Whole – abdomen enlarged, allergic reaction, asthenia, back pain, candidiasis, carcinoma, chest pain (not otherwise specified), chills, edema, fever, flu syndrome, halitosis, infection (not otherwise specified), malaise, neck pain, neck rigidity, pain, pelvic pain; *Cardiovascular System* - angina, arrhythmia, bradycardia, cerebrovascular accident/cerebral infarction, hypertension/hypotension, migraine, myocardial infarction, palpitations, shock (circulatory failure), syncope, tachycardia, vasodilation; *Digestive System* – abnormal stools, anorexia, bezoar, cardiospasm, cholelithiasis, colitis, dry mouth, dyspepsia, dysphagia, enteritis, eructation, esophageal stenosis, esophageal ulcer, esophagitis, fecal discoloration, flatulence, gastric nodules/fundic gland polyps, gastritis, gastroenteritis, gastrointestinal anomaly, gastrointestinal disorder, gastrointestinal hemorrhage, glossitis, gum hemorrhage, hematemesis, increased appetite, increased salivation, melena, mouth ulceration, nausea and vomiting, nausea and vomiting and diarrhea, oral moniliasis, rectal disorder, rectal hemorrhage, stomatitis, tenesmus, thirst, tongue disorder, ulcerative colitis, ulcerative stomatitis; *Endocrine System* - diabetes mellitus, goiter, hypothyroidism; *Hemic and Lymphatic System* - anemia, hemolysis, lymphadenopathy; *Metabolic and Nutritional Disorders* - gout, dehydration, hyperglycemia/hypoglycemia, peripheral edema, weight gain/loss; *Musculoskeletal System* - arthralgia, arthritis, bone disorder, joint disorder, leg cramps, musculoskeletal pain, myalgia, myasthenia, synovitis; *Nervous System* – abnormal dreams, agitation, amnesia, anxiety, apathy, confusion, convulsion, depersonalization, depression, diplopia, dizziness, emotional lability, hallucinations, hemiplegia, hostility aggravated, hyperkinesia, hypertonia, hypesthesia, insomnia, libido decreased/increased, nervousness, neurosis, paresthesia, sleep disorder, somnolence, thinking abnormality, tremor, vertigo; *Respiratory System* - asthma, bronchitis, cough increased, dyspnea, epistaxis, hemoptysis, hiccup, laryngeal neoplasia, pharyngitis, pleural disorder, pneumonia, respiratory disorder, upper respiratory inflammation/infection, rhinitis, sinusitis, stridor; *Skin and Appendages* - acne, alopecia, contact dermatitis, dry skin, fixed eruption, hair disorder, maculopapular rash, nail disorder, pruritus, rash, skin carcinoma, skin disorder, sweating, urticaria; *Special Senses* – abnormal vision, blurred vision, conjunctivitis, deafness, dry eyes, ear disorder, eye pain, otitis media, parosmia, photophobia, retinal degeneration, taste loss, taste perversion, tinnitus, visual field defect; *Urogenital System* - abnormal menses, breast enlargement, breast pain, breast tenderness, dysmenorrhea, dysuria, gynecomastia, impotence, kidney calculus, kidney pain, leukorrhea, menorrhagia, menstrual disorder, penis disorder, polyuria, testis disorder, urethral pain, urinary frequency, urinary tract infection, urinary urgency, urination impaired, vaginitis.

Postmarketing
On-going Safety Surveillance: Additional adverse experiences have been reported since lansoprazole has been marketed. The majority of these cases are foreign-sourced and a relationship to lansoprazole has not been established. Because these events were reported voluntarily from a population of unknown size, estimates of frequency cannot be made. These events are listed below by COSTART body system.

Body as a Whole - anaphylactoid-like reaction; *Digestive System* - hepatotoxicity, pancreatitis, vomiting; *Hemic and Lymphatic System* - agranulocytosis, aplastic anemia, hemolytic anemia, leukopenia, neutropenia, pancytopenia, thrombocytopenia, and thrombotic thrombocytopenic purpura; *Skin and Appendages* – severe dermatologic reactions including erythema multiforme, Stevens-Johnson syndrome, toxic epidermal necrolysis (some fatal); *Special Senses* - speech disorder; *Urogenital System* - urinary retention.

Combination Therapy with Amoxicillin and Clarithromycin
In clinical trials using combination therapy with PREVACID plus amoxicillin and clarithromycin, and PREVACID plus amoxicillin, no adverse reactions peculiar to these drug combinations were observed. Adverse reactions that have occurred have been limited to those that had been previously reported with PREVACID, amoxicillin, or clarithromycin.

Triple Therapy: PREVACID/amoxicillin/clarithromycin
The most frequently reported adverse events for patients who received triple therapy for 14 days were diarrhea (7%), headache (6%), and taste perversion (5%). There were no statistically significant differences in the frequency of reported adverse events between the 10- and 14-day triple therapy regimens. No treatment-emergent adverse events were observed at significantly higher rates with triple therapy than with any dual therapy regimen.

Dual Therapy: PREVACID/amoxicillin
The most frequently reported adverse events for patients who received PREVACID t.i.d. plus amoxicillin t.i.d. dual therapy were diarrhea (8%) and headache (7%). No treatment-emergent adverse events were observed at significantly higher rates with PREVACID t.i.d. plus amoxicillin t.i.d. dual therapy than with PREVACID alone.

For more information on adverse reactions with amoxicillin or clarithromycin, refer to their package inserts, **ADVERSE REACTIONS** sections.

Laboratory Values
The following changes in laboratory parameters for lansoprazole were reported as adverse events:

Abnormal liver function tests, increased SGOT (AST), increased SGPT (ALT), increased creatinine, increased alkaline phosphatase, increased globulins, increased GGTP, increased/decreased/abnormal WBC, abnormal AG ratio, abnormal RBC, bilirubinemia, eosinophilia, hyperlipemia, increased/decreased electrolytes, increased/decreased cholesterol, increased glucocorticoids, increased LDH, increased/decreased/abnormal platelets, and increased gastrin levels. Urine abnormalities such as albuminuria, glycosuria, and hematuria were also reported. Additional isolated laboratory abnormalities were reported.

In the placebo controlled studies, when SGOT (AST) and SGPT (ALT) were evaluated, 0.4% (4/978) placebo patients and 0.4% (11/2677) lansoprazole patients had enzyme elevations greater than three times the upper limit of normal range at the final treatment visit. None of these lansoprazole patients reported jaundice at any time during the study.

In clinical trials using combination therapy with PREVACID plus amoxicillin and clarithromycin, and PREVACID plus amoxicillin, no increased laboratory abnormalities particular to these drug combinations were observed.

For more information on laboratory value changes with amoxicillin or clarithromycin, refer to their package inserts, **ADVERSE REACTIONS** section.

OVERDOSAGE
Oral doses up to 5000 mg/kg in rats (approximately 1300 times the recommended human dose based on body surface area) and mice (about 675.7 times the recommended human dose based on body surface area) did not produce deaths or any clinical signs.

Lansoprazole is not removed from the circulation by hemodialysis. In one reported case of overdose, the patient consumed 600 mg of lansoprazole with no adverse reaction.

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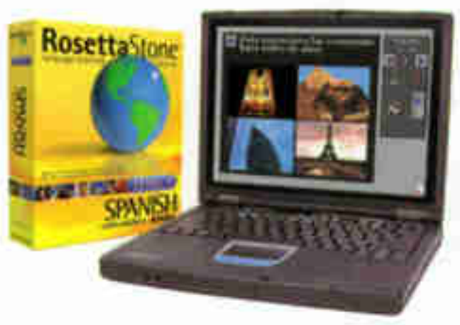

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Visions of Earth

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Silently I begged this Dalmatian pelican: Please, open your eyes! But not until I tapped my wedding band against my tripod did it grace me with a striking stare, as if to reprimand me for disturbing its sleep. Rainy weather had thwarted my previous attempts to photograph migrating pelicans on their stopover at a small island along the Danube. So I was transfixed by this moment, by the bird's form and texture and spirit.

—Helmut Moik

▶Decorate your desktop with this Dalmatian pelican at **nationalgeographic.com/magazine/0504**.

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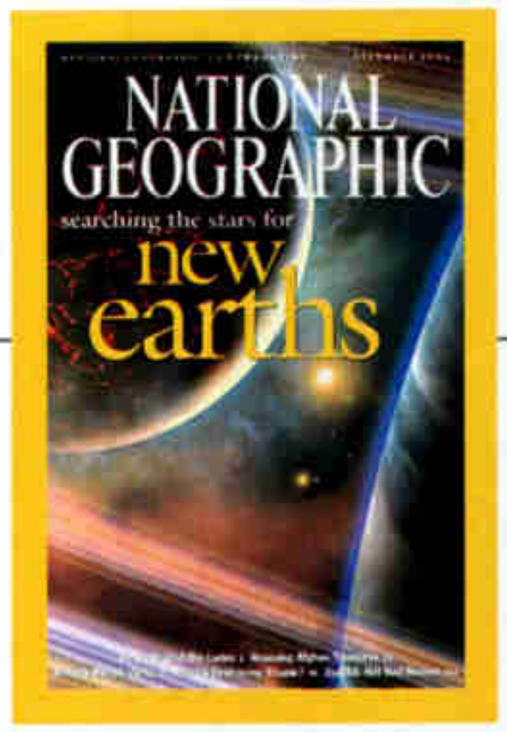

December 2004

Many readers debated the broad ideas covered in this month's issue. Some were excited at the prospect of planets like our own in "Someplace Like Earth," but others felt that resources should be focused on Earth first. One reader found irony in our stories. "We are on the cusp of discovering planets like Earth billions of miles away, while at the same time we can't find Osama bin Laden here on our own planet."

Someplace Like Earth

I thoroughly enjoyed this well-written article but saw no mention of what we would do if we found a habitable planet or planets. With the awesome astronomical distances involved, it could take many lifetimes just to say "Hello"!

RICHARD D. STACY
Montrose, California

The human race exerts such considerable effort and thought to locate other habitable planets with life while being so hell-bent on destroying the habitability of our own planet. It is imperative to the future of our species that we focus more on being good stewards of our mother ship Earth before setting our sights on other worlds to exploit.

CHRISTIAN GLENN
Woodbridge, Virginia

The thought that remained with me after reading the article is that the star-wobble method of planet detection seems to have limited application. If a star has multiple planets, each planet could alter or reduce the effects of another planet's pull on the star, affecting the star wobble or even making it undetectable. I wonder if the astronomers feel that this procedure for planet detection is going to miss some stars that do have planets?

DICK MASTIN
Alto, New Mexico

According to Alan Boss, an astrophysicist at the Department of Terrestrial Magnetism, Carnegie Institution of Washington, when there are several planets in the same system, their pulls on the central star at times cancel each other out. At other times their pulls add together and produce an even larger wobble of the star, making the presence of the planets even easier to detect. As long as there are enough data, it's possible to disentangle the effects of the different planets and determine their orbits.

On the Trail of bin Laden

In every issue of your magazine there is at least one image that grips me. This time there were

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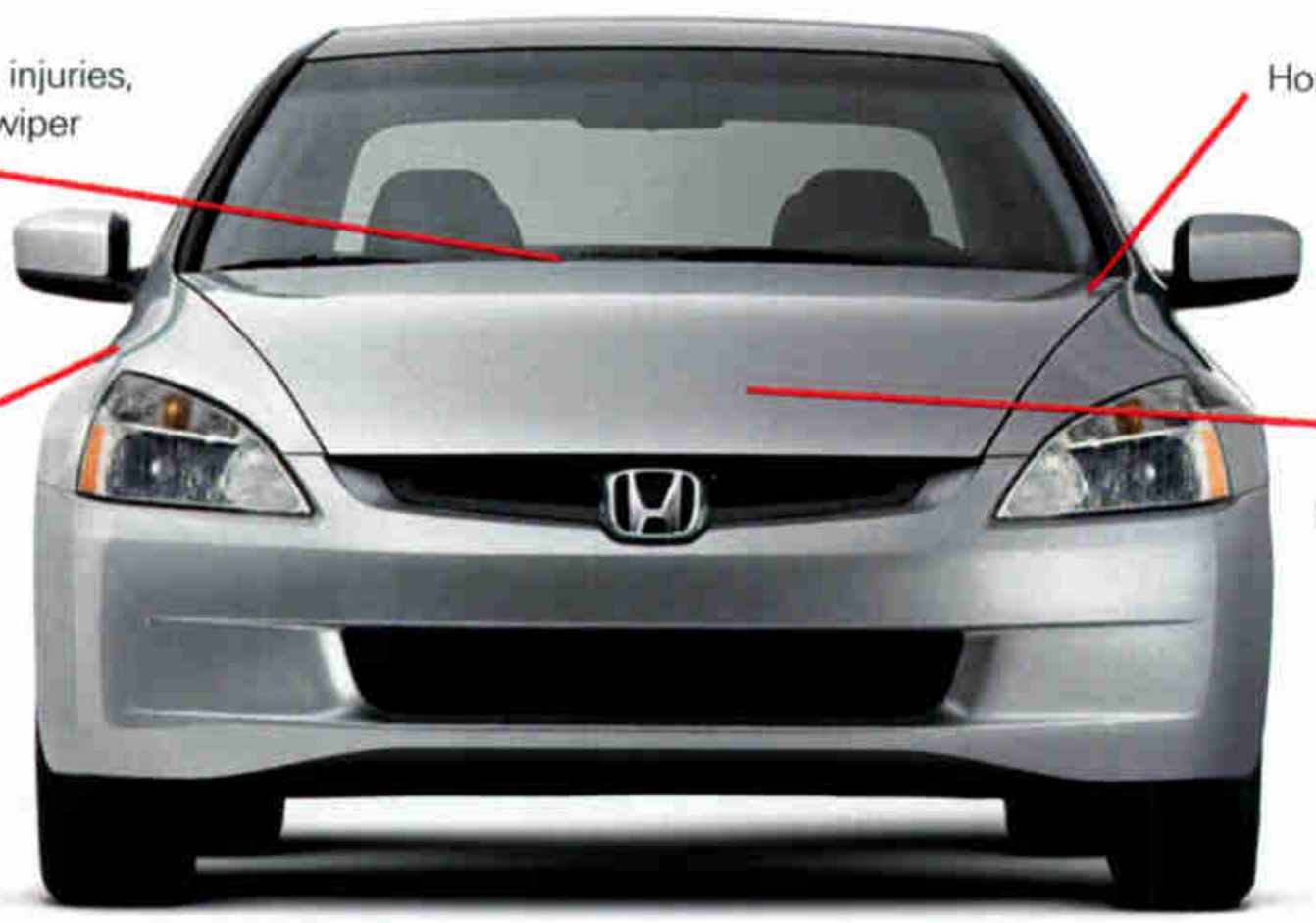
Every car company is concerned about the people inside its cars.

But what about the people outside?



As part of Honda's commitment to "Safety for Everyone," we are leading the industry in technology to help protect pedestrians in the event of an accident. Approximately 70,000 pedestrians a year are involved in traffic crashes. And about 5,000 of these end in fatalities. In our efforts to help reduce injuries, especially to the head, Honda created POLAR II, a unique pedestrian test dummy with sensors that help analyze the types of injuries that could be sustained in an accident. Our pioneering research has led to the development of a number of pedestrian-protection features, including injury-reducing designs that minimize direct contact with the most rigid part of the vehicle. More than 2 million U.S. Honda and Acura vehicles on the road today have this equipment. Honda is firmly committed to advancing our safety technologies, with our goal of "Safety for Everyone" leading the way.

Created by Honda engineers, POLAR II is the most advanced pedestrian test dummy, and simulates the kinematics of the human body.

POLAR II has instruments that measure the level of injury throughout the body, including the head, neck, chest, abdomen and legs.

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Titanic Revisited

Robert Ballard decries the legal salvage of thousands of artifacts from the wreck site. However, he fails to mention that these artifacts have been restored and put on display in exhibits worldwide. I've seen the exhibits in nearly a dozen cities. Seeing the *Titanic* artifacts up close offers a personal connection with history that video images and photographs simply cannot give.

MARY ANN WHITLEY
Trustee, Titanic International Society
University Heights, Ohio

As much as we benefit from exploration and discovery, the accelerated decay of the *Titanic* should remind us that we can't just dig up something amazing and walk away. Perhaps it's better to leave artifacts undiscovered until the appropriate resources and treaties are in place to ensure their preservation. Otherwise, discovery becomes a mere handmaiden to destruction.

ANDREW G. PIZOR
Dothan, Alabama

INSTITUTE FOR EXPLORATION/INSTITUTE FOR ARCHAEOLOGICAL OCEANOGRAPHY, UNIVERSITY OF RHODE ISLAND

Preservation of shipwrecks is not the absence of human contact, nor is it the passing of laws preventing the discovery and visitation of such sites, inevitably allowing shipwrecks to dissolve into the ocean floor. Preservation of maritime history can only be accomplished by the organized research, restoration, and display of relics.

STEVE LAWSON
Laguna Hills, California

Ballard seems to think he owns the *Titanic* wreckage and bemoans the fact that the ship is wasting away. In fact, the ship should waste away since it never should have been there in the first place. The wreckage is an unnatural object on the ocean floor that I hope before long will be mostly a pile of iron oxide. Besides, the *Titanic* wreckage is no more a "sacred grave" than any other shipwreck or location on land that involved loss of life.

KEN BISHOP
Lake Jackson, Texas

the portraits of the girl near Tora Bora and the U.S. Army soldier Neville Bridgeford. To put these photos side by side was a stroke of genius. I haven't seen a more honest portrayal of the world that we live in. These human beings are separated by age, culture, and thousands of miles, but in their eyes you can see the same thing: hope.

IAN MCLEOD
Rugby, Warwickshire

I was pleased to see an article about Afghanistan and was surprised to recognize the author, Tim McGirk. I remember meeting him in 1997 at age 13, when my parents were development workers in Mazar-e Sharif in northern Afghanistan. Following a brief Taliban takeover of the city and a 15-hour gun battle, my family evacuated the city in a United Nations convoy. Tim McGirk was among a number of reporters who were covering the event and also left in the same convoy. I remember him giving me an orange as we waited to cross the border into Uzbekistan and then helping me carry my large bag along Friendship Bridge. I would like to thank him for not only an excellent article but also for taking the time to show kindness and respect to a young boy.

BENJAMIN OLSON
Elbow, Saskatchewan

After reading this fascinating article, I was rather disappointed in the clear American bias that ran throughout. Except for the mention on page 18 of the "U.S.-led coalition forces," one would think that only American forces were involved in Afghanistan.

HUGUETTE CHAMPAGNE
Saint John, New Brunswick

An image depicting U.S. helicopters patrolling Pashtun lands is described as a "happy picture." It is hard to imagine that foreign helicopters watching you and controlling the airspace over your homeland could ever really be happy.

WINSTON THOMSON
Roswell, Georgia

As a longtime Muslim reader of NATIONAL GEOGRAPHIC, I was morbidly amused to read how

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MAKING SENSE OF INVESTING

Tim McGirk explained to the Wazir tribesmen that the U.S. was in Afghanistan to seek revenge for September 11. What déjà vu! Another in a long line of white men telling the natives why some of them had to die.

A. M. EL-KAISSOUNI
Cairo, Egypt

Osama bin Laden may be a hero to his terrorist clique, but he does not belong to the Islamic world. Teachings of Islam are entirely different from what is being portrayed in the messages from al Qaeda. Islam teaches peace and brotherhood. According to Muhammad, the last Prophet of Allah, killing an innocent being is like killing all humanity.

ZILL-E-REHMAN KHAN NIAZI
Dera Ghazi Khan, Pakistan

FROM OUR ONLINE FORUM
nationalgeographic.com/magazine/0412

It does not really matter whether bin Laden will ever be caught dead or alive. The way we are fighting the war on terror makes it a losing battle. Someone else will take his place if it has not happened already.

AL ARVIZU
Huntington Beach, California

FROM OUR ONLINE FORUM
nationalgeographic.com/magazine/0412

Behind the Scenes

Thank you for the piece about my reunion with my brother, Paul. It is very gratifying to note that NATIONAL GEOGRAPHIC shows an interest in the individual.

FRED SEIKER
Worcester, England

My daughter and I visited the Naj Tunich cave in Guatemala in July 1981, a month before your issue came out. I still look at those black-and-white photos taken all those years ago and feel so privileged to have seen such a historic site. What a shame thoughtless people have destroyed it.

GLENN WILLIAMS
Beaumont, California

It's ironic that the human race exerts such considerable effort to locate other habitable planets while being so hell-bent on destroying the habitability of our own planet.

ZipUSA: Hartsville, South Carolina

It was surprising and disturbing to open this issue's pages to a ZipUSA story on drag racing, "Zoom Town," that highlights excessive burning of fossil fuels. November's ZipUSA, "Nature's Lessons," covered a low-impact community where environmental education is taught in the midst of the Grand Teton National Park. A better name for these stories may be National Diversity.

JENNIFER SMITH
Yaak, Montana

Geographica: A Work-Weary World?

I found your article fascinating. The yearly work hours around the globe are surprisingly low! My husband and I are self-employed, each averaging 2,496 work hours a year, and have had only three weeks of vacation in 18 years. But with three children to educate and no pension, we "make hay while the sun shines." Yes, I'd say we are work-weary. Maybe we should move to Norway.

ANNE WHEATLEY
London, Ontario

Saving Afghan Treasures

As a practicing Buddhist, I find some irony in your article describing the efforts to save the artifacts at Bamian, Afghanistan. The historical Buddha, like Muhammad, did not support being portrayed as an idol. He would have much preferred the tribal members who were living in the caves be sheltered there and that the money being used to restore Buddhist relics be spent on alleviating suffering. Having been an artist during one phase of my life, I also appreciate the value of art and cultural heritage, but it saddens me to read of this conflict in which the basic human needs of the population are neglected.

PETER CARLSON
Winter Park, Florida

My Seven: Inking Man's Magazine

Who cares what inspires tattoo "artistry." Your mere mention is an uncalled for advertisement for an industry/fad that ruins peoples lives. Why not focus on true art? What next, some dude's inspiration for his latest piercing?

CHRIS COTT
San Diego, California

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	LONG-LASTING*	NON-DROWSY
Allegra 180mg	✓	✓
Benadryl ALLERGY		
TYLENOL SEVERE ALLERGY FAST RELIEF		
Chlor-Trimeton Allergy		

One dose of non-drowsy Allegra 180mg lasts 4X longer than one dose of most over-the-counter allergy products.*

For people 12 and over. Side effects with Allegra 180mg are low and may include headache, cold or backache.
Please see additional important information on next page.

ALLEGRA. THE RELIEF GOES ON.

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Rev. May 2003a
Brief Summary

ALLEGRA®
(fexofenadine hydrochloride)
Capsules and Tablets

INDICATIONS AND USAGE **Seasonal Allergic Rhinitis** ALLEGRA is indicated for the relief of symptoms associated with seasonal allergic rhinitis in adults and children 6 years of age and older. Symptoms treated effectively were sneezing, rhinorrhea, itchy nose/palate/throat, itchy/watery/red eyes. **Chronic Idiopathic Urticaria** ALLEGRA is indicated for treatment of uncomplicated skin manifestations of chronic idiopathic urticaria in adults and children 6 years of age and older. It significantly reduces pruritus and the number of wheals. **CONTRAINDICATIONS** ALLEGRA is contraindicated in patients with known hypersensitivity to any of its ingredients. **PRECAUTIONS** **Drug Interaction with Erythromycin and Ketoconazole** Fexofenadine hydrochloride has been shown to exhibit minimal (ca. 5%) metabolism. However, co-administration of fexofenadine hydrochloride with ketoconazole and erythromycin led to increased plasma levels of fexofenadine hydrochloride. Fexofenadine hydrochloride had no effect on the pharmacokinetics of erythromycin and ketoconazole. In two separate studies, fexofenadine hydrochloride 120 mg twice daily (two times the recommended twice daily dose) was co-administered with erythromycin 500 mg every 8 hours or ketoconazole 400 mg once daily under steady state conditions to normal, healthy volunteers (n=24, each study). No differences in adverse events or QT_c interval were observed when patients were administered fexofenadine hydrochloride alone or in combination with erythromycin or ketoconazole. The findings of these studies are summarized in the following table:

Effects on steady-state fexofenadine hydrochloride pharmacokinetics after 7 days of co-administration with fexofenadine hydrochloride 120 mg every 12 hours (two times the recommended twice daily dose) in normal volunteers (n=24)

Concomitant Drug	C_{maxSS} *(Peak plasma concentration)*	$AUC_{(0-12h)}$ *(Extent of systemic exposure)*
Erythromycin (500 mg every 8 hrs)	+82%	+109%
Ketoconazole (400 mg once daily)	+135%	+164%

The changes in plasma levels were within the range of plasma levels achieved in adequate and well-controlled clinical trials. The mechanism of these interactions has been evaluated in *in vitro*, *in situ*, and *in vivo* animal models. These studies indicate that ketoconazole or erythromycin co-administration enhances fexofenadine gastrointestinal absorption. *In vivo* animal studies also suggest that in addition to increasing absorption, ketoconazole decreases fexofenadine hydrochloride gastrointestinal secretion, while erythromycin may also decrease biliary excretion. **Drug Interactions with Antacids** Administration of 120 mg of fexofenadine hydrochloride (2 x 60 mg capsule) within 15 minutes of an aluminum and magnesium containing antacid (Maalox®) decreased fexofenadine AUC by 41% and C_{max} by 43%. ALLEGRA should not be taken closely in time with aluminum and magnesium containing antacids. **Carcinogenesis, Mutagenesis, Impairment of Fertility** The carcinogenic potential and reproductive toxicity of fexofenadine hydrochloride were assessed using terfenadine studies with adequate fexofenadine hydrochloride exposure (based on plasma area-under-the-concentration vs. time [AUC] values). No evidence of carcinogenicity was observed in an 18-month study in mice and in a 24-month study in rats at oral doses up to 150 mg/kg of terfenadine (which led to fexofenadine exposures that were respectively approximately 3 and 5 times the exposure from the maximum recommended daily oral dose of fexofenadine hydrochloride in adults and children). In *in vitro* (Bacterial Reverse Mutation, CHO/HGPRT Forward Mutation, and Rat Lymphocyte Chromosomal Aberration assays) and *in vivo* (Mouse Bone Marrow Micronucleus assay) tests, fexofenadine hydrochloride revealed no evidence of mutagenicity. In rat fertility studies, dose-related reductions in implants and increases in postimplantation losses were observed at an oral dose of 150 mg/kg of terfenadine (which led to fexofenadine hydrochloride exposures that were approximately 3 times the exposure of the maximum recommended daily oral dose of fexofenadine hydrochloride in adults). **Pregnancy** **Teratogenic Effects: Category C.** There was no evidence of teratogenicity in rats or rabbits at oral doses of terfenadine up to 300 mg/kg (which led to fexofenadine exposures that were approximately 4 and 31 times, respectively, the exposure from the maximum recommended daily oral dose of fexofenadine in adults). There are no adequate and well controlled studies in pregnant women. Fexofenadine should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus. **Nonteratogenic Effects.** Dose-related decreases in pup weight gain and survival were observed in rats exposed to an oral dose of 150 mg/kg of terfenadine (approximately 3 times the maximum recommended daily oral dose of fexofenadine hydrochloride in adults based on comparison of fexofenadine hydrochloride AUCs). **Nursing Mothers** There are no adequate and well-controlled studies in women during lactation. Because many drugs are excreted in human milk, caution should be exercised when fexofenadine hydrochloride is administered to a nursing woman. **Pediatric Use** The recommended dose in patients 6 to 11 years of age is based on cross-study comparison of the pharmacokinetics of ALLEGRA in adults and pediatric patients and on the safety profile of fexofenadine hydrochloride in both adult and pediatric patients at doses equal to or higher than the recommended doses. The safety of ALLEGRA tablets at a dose of 30 mg twice daily has been demonstrated in 438 pediatric patients 6 to 11 years of age in two placebo-controlled 2-week seasonal allergic rhinitis trials. The safety of ALLEGRA for the treatment of chronic idiopathic urticaria in patients 6 to 11 years of age is based on cross-study comparison of the pharmacokinetics of ALLEGRA in adult and pediatric patients and on the safety profile of fexofenadine in both adult and pediatric patients at doses equal to or higher than the recommended dose. The effectiveness of ALLEGRA for the treatment of seasonal allergic rhinitis in patients 6 to 11 years of age was demonstrated in one trial (n=411) in which ALLEGRA tablets 30 mg twice daily significantly reduced total symptom scores compared to placebo, along with extrapolation of demonstrated efficacy in patients ages 12 years and above, and the pharmacokinetic comparisons in adults and children. The effectiveness of ALLEGRA for the treatment of chronic idiopathic urticaria in patients 6 to 11 years of age is based on an extrapolation of the demonstrated efficacy of ALLEGRA in adults with this condition and the likelihood that the disease course, pathophysiology and the drug's effect are substantially similar in children to that of adult patients. Three clinical safety studies comparing 15 mg BID (n=85) and 30 mg BID (n=330) of an experimental formulation of fexofenadine to placebo (n=430) have been conducted in pediatric patients aged 6 months to 5 years. In general, fexofenadine hydrochloride was well tolerated in these studies. No unexpected adverse events were seen given the known safety profile of fexofenadine and likely adverse reactions for this patient population. (See ADVERSE REACTIONS and CLINICAL PHARMACOLOGY.) The safety and effectiveness of fexofenadine hydrochloride in pediatric patients under 6 years of age have not been established. **Geriatric Use** Clinical studies of ALLEGRA tablets and capsules did not include sufficient numbers of subjects aged 65 years and over to determine whether this population responds differently from younger patients. Other reported clinical experience has not identified differences in responses between the geriatric and younger patients. This drug is known to be substantially excreted by the kidney, and the risk of toxic reactions to this drug may be greater in patients with impaired renal function. Because elderly patients are more likely to have decreased renal function, care should be taken in dose selection, and may be useful to monitor renal function. (See CLINICAL PHARMACOLOGY). **ADVERSE REACTIONS** **Seasonal Allergic Rhinitis** **Adults.** In placebo-controlled seasonal allergic rhinitis clinical trials in patients 12 years of age and older, which included 2461 patients receiving fexofenadine hydrochloride capsules at doses of 20 mg to 240 mg twice daily, adverse events were similar in fexofenadine hydrochloride and placebo-treated patients. All adverse events that were reported by greater than 1% of patients who received the recommended daily dose of fexofenadine hydrochloride (60 mg capsules twice daily), and that were more common with fexofenadine hydrochloride than placebo, are listed in Table 1. In a placebo-controlled clinical study in the United States, which included 570 patients aged 12 years and older receiving fexofenadine hydrochloride tablets at doses of 120 or 180 mg once daily, adverse events were similar in fexofenadine hydrochloride and placebo-treated patients. Table 1 also lists adverse experiences that were reported by greater than 2% of patients treated with fexofenadine hydrochloride tablets at doses of 180 mg once daily and that were more common with fexofenadine hydrochloride than placebo. The incidence of adverse events, including drowsiness, was not dose-related and was similar across subgroups defined by age, gender, and race.

Table 1
Adverse experiences in patients ages 12 years and older reported in placebo-controlled seasonal allergic rhinitis clinical trials in the United States

Twice daily dosing with fexofenadine capsules at rates of greater than 1%

Adverse experience	*Fexofenadine 60 mg Twice Daily (n=679)*	*Placebo Twice Daily (n=671)*
Viral Infection (cold, flu)	2.5%	1.5%
Nausea	1.6%	1.5%
Dysmenorrhea	1.5%	0.3%
Drowsiness	1.3%	0.9%
Dyspepsia	1.3%	0.6%
Fatigue	1.3%	0.9%

Once daily dosing with fexofenadine hydrochloride tablets at rates of greater than 2%

Adverse experience	*Fexofenadine 180 mg once daily (n=283)*	*Placebo (n=293)*
Headache	10.6%	7.5%
Upper Respiratory Tract Infection	3.2%	3.1%
Back Pain	2.8%	1.4%

The frequency and magnitude of laboratory abnormalities were similar in fexofenadine hydrochloride and placebo-treated patients. **Pediatric.** Table 2 lists adverse experiences in patients aged 6 to 11 years of age which were reported by greater than 2% of patients treated with fexofenadine hydrochloride tablets at a dose of 30 mg twice daily in placebo-controlled seasonal allergic rhinitis studies in the United States and Canada that were more common with fexofenadine hydrochloride than placebo.

Table 2
Adverse experiences reported in placebo-controlled seasonal allergic rhinitis studies in pediatric patients ages 6 to 11 in the United States and Canada at rates of greater than 2%

Adverse experience	*Fexofenadine 30 mg twice daily (n=209)*	*Placebo (n=229)*
Headache	7.2%	6.6%
Accidental Injury	2.9%	1.3%
Coughing	3.8%	1.3%
Fever	2.4%	0.9%
Pain	2.4%	0.4%
Otitis Media	2.4%	0.0%
Upper Respiratory Tract Infection	4.3%	1.7%

Three clinical safety studies in 845 children aged 6 months to 5 years comparing 15 mg BID (n=85) and 30 mg BID (n=330) of an experimental formulation of fexofenadine to placebo (n=430) have been conducted. In general, fexofenadine hydrochloride was well tolerated in these studies. No unexpected adverse events were seen given the known safety profile of fexofenadine and likely adverse reactions for this patient population. (See PRECAUTIONS Pediatric Use.) **Chronic Idiopathic Urticaria** Adverse events reported by patients 12 years of age and older in placebo-controlled chronic idiopathic urticaria studies were similar to those reported in placebo-controlled seasonal allergic rhinitis studies. In placebo-controlled chronic idiopathic urticaria clinical trials, which included 726 patients 12 years of age and older receiving fexofenadine hydrochloride tablets at doses of 20 to 240 mg twice daily, adverse events were similar in fexofenadine hydrochloride and placebo-treated patients. Table 3 lists adverse experiences in patients aged 12 years and older which were reported by greater than 2% of patients treated with fexofenadine hydrochloride 60 mg tablets twice daily in controlled clinical studies in the United States and Canada and that were more common with fexofenadine hydrochloride than placebo. The safety of fexofenadine hydrochloride in the treatment of chronic idiopathic urticaria in pediatric patients 6 to 11 years of age is based on the safety profile of fexofenadine hydrochloride in adults and adolescent patients at doses equal to or higher than the recommended dose (see Pediatric Use).

Table 3
Adverse experiences reported in patients 12 years and older in placebo-controlled chronic idiopathic urticaria studies in the United States and Canada at rates of greater than 2%

Adverse experience	*Fexofenadine 60 mg twice daily (n=186)*	*Placebo (n=178)*
Back Pain	2.2%	1.1%
Sinusitis	2.2%	1.1%
Dizziness	2.2%	0.6%
Drowsiness	2.2%	0.0%

Events that have been reported during controlled clinical trials involving seasonal allergic rhinitis and chronic idiopathic urticaria patients with incidences less than 1% and similar to placebo and have been rarely reported during postmarketing surveillance include: insomnia, nervousness, and sleep disorders or paroniria. In rare cases, rash, urticaria, pruritus and hypersensitivity reactions with manifestations such as angioedema, chest tightness, dyspnea, flushing and systemic anaphylaxis have been reported. **OVERDOSAGE** Reports of fexofenadine hydrochloride overdose have been infrequent and contain limited information. However, dizziness, drowsiness, and dry mouth have been reported. Single doses of fexofenadine hydrochloride up to 800 mg (six normal volunteers at this dose level), and doses up to 690 mg twice daily for 1 month (three normal volunteers at this dose level) or 240 mg once daily for 1 year (234 normal volunteers at this dose level) were administered without the development of clinically significant adverse events as compared to placebo. In the event of overdose, consider standard measures to remove any unabsorbed drug. Symptomatic and supportive treatment is recommended. Hemodialysis did not effectively remove fexofenadine hydrochloride from blood (1.7% removed) following terfenadine administration. No deaths occurred at oral doses of fexofenadine hydrochloride up to 5000 mg/kg in mice (110 times the maximum recommended daily oral dose in adults and 200 times the maximum recommended daily oral dose in children based on mg/m^2) and up to 5000 mg/kg in rats (230 times the maximum recommended daily oral dose in adults and 400 times the maximum recommended daily oral dose in children based on mg/m^2). Additionally, no clinical signs of toxicity or gross pathological findings were observed. In dogs, no evidence of toxicity was observed at oral doses up to 2000 mg/kg (300 times the maximum recommended daily oral dose in adults and 530 times the maximum recommended daily oral dose in children based on mg/m^2). **DOSAGE AND ADMINISTRATION** **Seasonal Allergic Rhinitis** **Adults and Children 12 Years and Older.** The recommended dose of ALLEGRA is 60 mg twice daily, or 180 mg once daily. A dose of 60 mg once daily is recommended as the starting dose in patients with decreased renal function (see CLINICAL PHARMACOLOGY). **Children 6 to 11 Years.** The recommended dose of ALLEGRA is 30 mg twice daily. A dose of 30 mg once daily is recommended as the starting dose in pediatric patients with decreased renal function (see CLINICAL PHARMACOLOGY). **Chronic Idiopathic Urticaria** **Adults and Children 12 Years and Older.** The recommended dose of ALLEGRA is 60 mg twice daily. A dose of 60 mg once daily is recommended as the starting dose in patients with decreased renal function (see CLINICAL PHARMACOLOGY). **Children 6 to 11 Years.** The recommended dose of ALLEGRA is 30 mg twice daily. A dose of 30 mg once daily is recommended as the starting dose in pediatric patients with decreased renal function (see CLINICAL PHARMACOLOGY).

Please see product circular for full prescribing information.

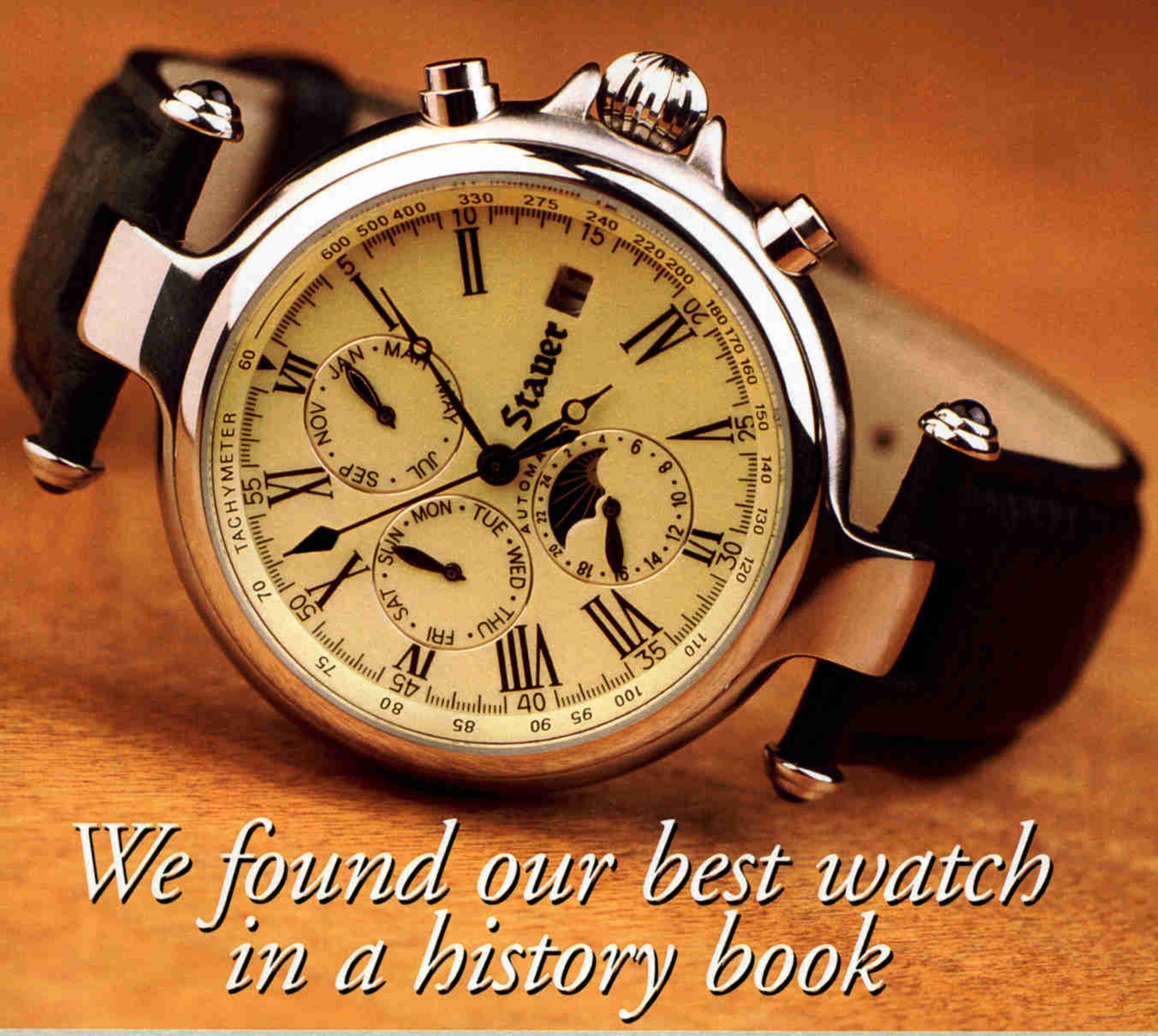
Rx only

Rev. May 2003a
Brief Summary

Aventis Pharmaceuticals Inc.
Kansas City, MO 64137 USA
US Patents 4,254,129; 5,375,693; 5,578,610

www.allegra.com

all-may03a-8-Aj



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GEOGR

THE PEOPLE, PLACES, AND

Waves 30 feet high blasted ashore at Khao Lak, in Thailand's hardest hit region. Here and along the shattered coast of Indonesia's Sumatra island, the tsunami arrived mostly as a series of breaking waves. In Sri Lanka and India, where the offshore waters are deeper, the tsunami poured in like a tidal surge.

APHICA

CREATURES OF OUR UNIVERSE

NATURAL DISASTERS

Tsunamis—Where Next?

With danger waiting in every ocean, detection is key

Warning came too late or not at all last December. The count of dead and missing now numbers 300,000, and millions more have lost homes and livelihoods in the wake of the earthquake-generated tsunami that struck more than a dozen countries throughout the Indian Ocean. Many of the communities hit had virtually no memory of a powerful tsunami or what the warning signs of an approaching one would be—the last oceanwide wave, from the eruption of Krakatau off southern Sumatra, occurred in 1883. Lacking that knowledge and any kind of detection or warning systems in the Indian Ocean, coastal areas were defenseless against the waves.

With tectonic plates groaning against each other or pulling apart on every ocean floor, the risks of large submarine quakes and resulting tsunamis have galvanized scientists and planners to prepare for the next onslaught. Since 1992, 17 major tsunamis have struck, 11 in the Pacific. Fatalities were relatively low, a total of some 4,000—until last year.

Burgeoning coastal populations have multiplied the human costs of a wave strike like the one last December 26. To forestall another catastrophe, world leaders have announced plans for tsunami detection and warning systems in the Indian Ocean. The existing network of underwater sensors in the Pacific, site of 85 percent of all tsunamis, will be increased and expanded into the Atlantic and Caribbean. Environmentalists are pushing for a further line of defense: planting more mangrove forests as wave barriers.

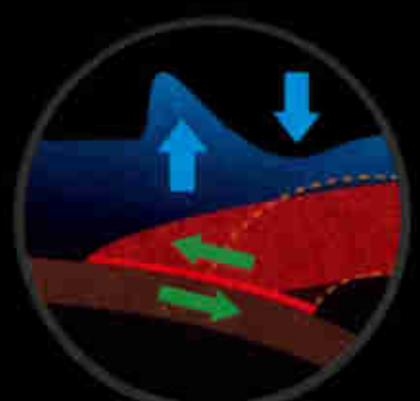
Early warning systems and more coastal vegetation might have saved many of the 1,800 victims drowned or crushed by debris in Khao Lak, Thailand. Almost two hours passed from the time the quake occurred until the wall of water tore through hotels and huts there. Amid the rubble Kusol Wetchakul, at left, prayed for his missing sister, believed swept away by the unstoppable water.

DAVID LONGSTREATH, AP/WIDE WORLD PHOTOS

Tsunami Triggers

Earthquakes

The most destructive and common tsunamis are spawned by earthquakes. To deform the sea bottom and displace enough water to propel wave pulses for a thousand miles or more, a quake has to be colossal, at least magnitude 7.5. Typically, a tsunami quake occurs at a thrust fault, where an ocean plate dives under a continental plate, dragging it down until the fault snaps, causing an earthquake that lifts the seafloor.

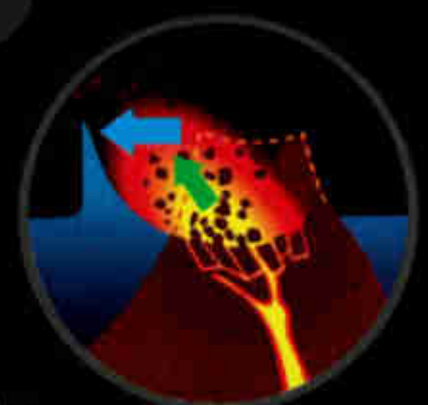


WHERE NEXT?

Russia's Kamchatka Peninsula and the coastline along the border of Peru and Chile are among the most "tsunamigenic" in the world.

Volcanoes

A classic aboveground eruption is just one of the ways a volcano can disturb the ocean and generate a tsunami. Waves can also be triggered by submarine events—eruptions, cascades of ash, or the collapse of a volcanic flank. The 1883 volcanic explosion of Krakatau and the collapse of its caldera stirred up 130-foot-high waves and killed some 36,000 people.



WHERE NEXT?

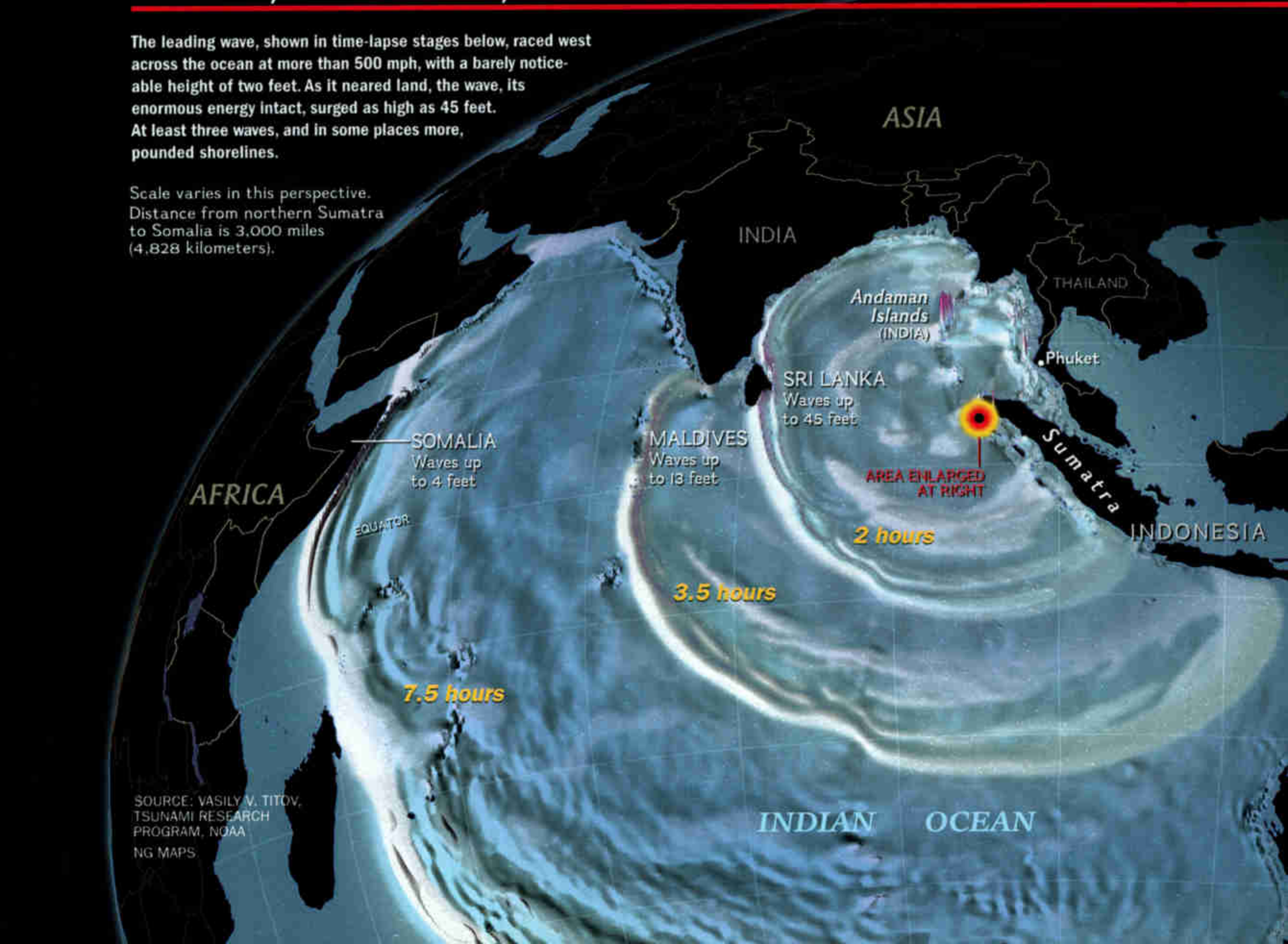
The submarine Loihi Volcano southeast of the Big Island of Hawaii and the Izu volcanic arc off the east coast of Japan are being closely watched.

INSETS NOT TO SCALE

Sumatra, December 26, 2004

The leading wave, shown in time-lapse stages below, raced west across the ocean at more than 500 mph, with a barely noticeable height of two feet. As it neared land, the wave, its enormous energy intact, surged as high as 45 feet. At least three waves, and in some places more, pounded shorelines.

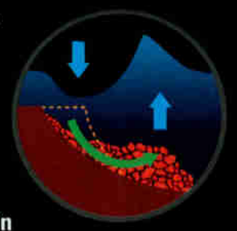
Scale varies in this perspective. Distance from northern Sumatra to Somalia is 3,000 miles (4,828 kilometers).



SOURCE: VASILY V. TITOV, TSUNAMI RESEARCH PROGRAM, NOAA

NG MAPS

Landslides

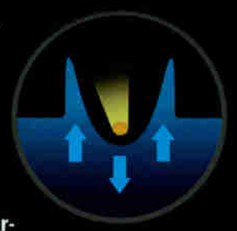


The violent displacement of water from landslides, usually set off by earthquakes, and from rock- and icefalls can create powerful local tsunamis. The highest recorded swept Lituya Bay, Alaska, in 1958, when a quake-triggered rockfall threw up a 1,720-foot wave—267 feet higher than the Empire State Building.

WHERE NEXT?

Continental shelves where sediments collect and the unstable flanks of volcanoes are landslide prone. Scientists are keeping an eye on the west coast of the U.S. off Santa Barbara, California, and the east coast off southern Virginia and North Carolina.

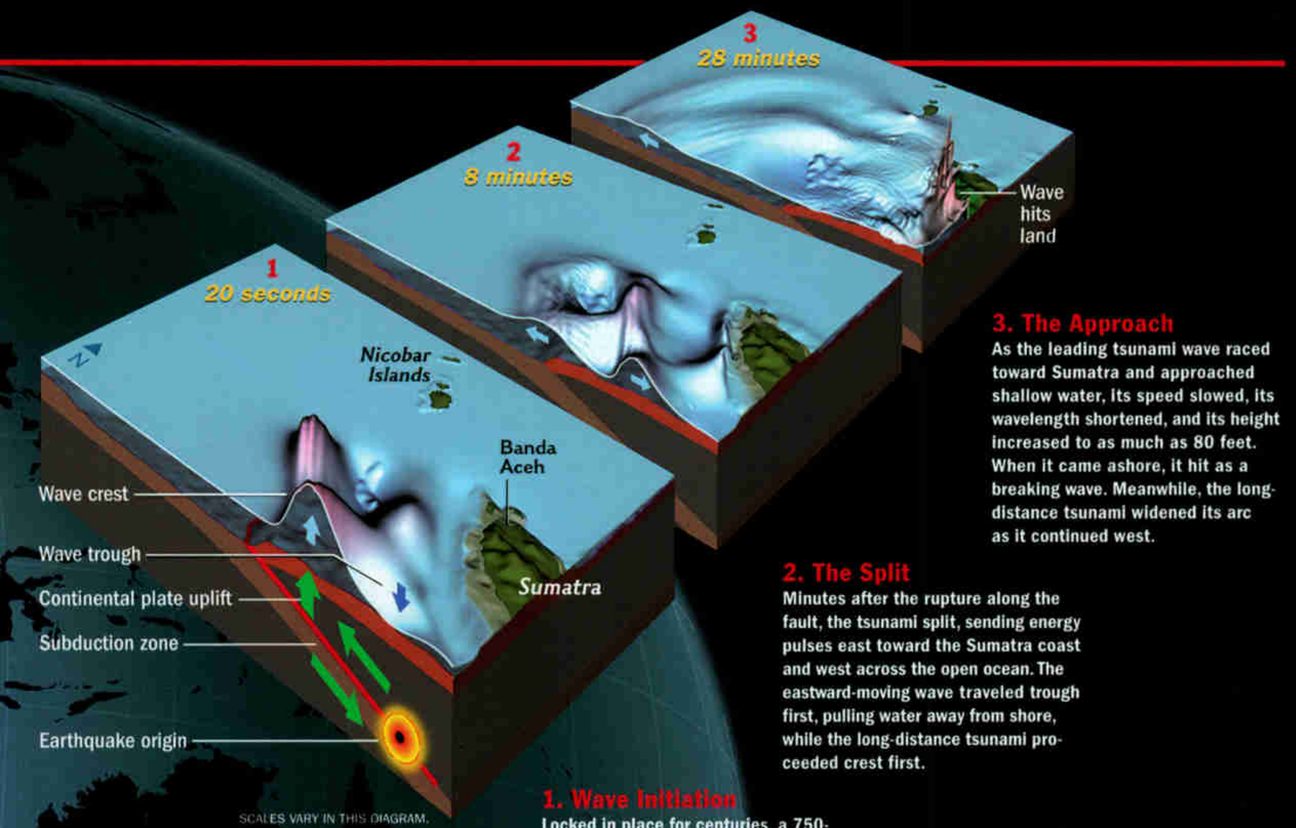
Asteroids



A Hollywood-style, doomsday tsunami washing over New York City and pouring inland as far as the Appalachian Mountains could happen if an asteroid of three to four miles in diameter hurtled into the middle of the Atlantic Ocean. While no known asteroid or comet has hit Earth during recorded history, 35 million years ago one blasted a 53-mile-wide crater under what is now the southern end of the Chesapeake Bay. The resulting waves—possibly thousands of feet high—roared inland for hundreds of miles.

WHERE NEXT?

With luck, some other planet.



3. The Approach

As the leading tsunami wave raced toward Sumatra and approached shallow water, its speed slowed, its wavelength shortened, and its height increased to as much as 80 feet. When it came ashore, it hit as a breaking wave. Meanwhile, the long-distance tsunami widened its arc as it continued west.

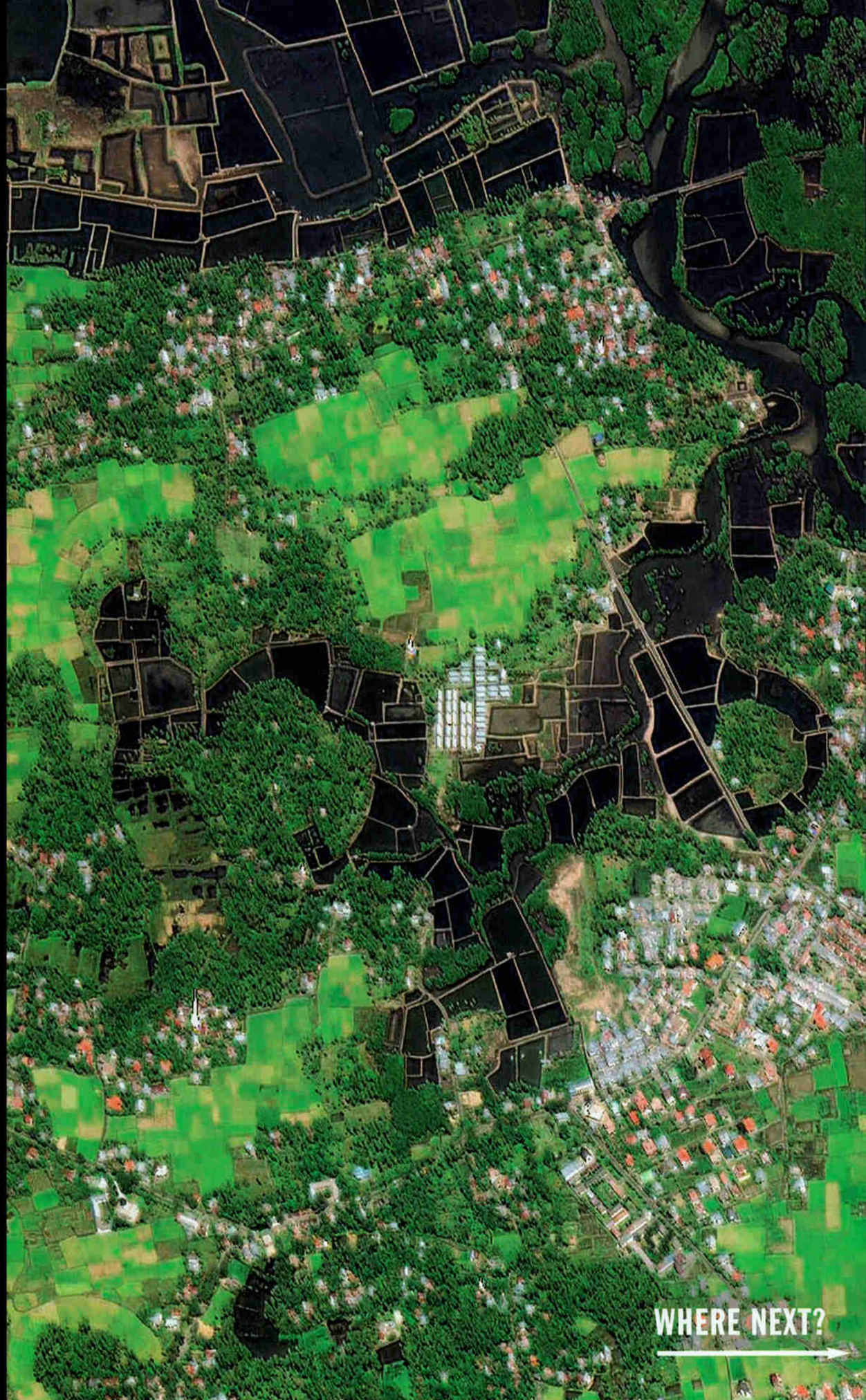
2. The Split

Minutes after the rupture along the fault, the tsunami split, sending energy pulses east toward the Sumatra coast and west across the open ocean. The eastward-moving wave traveled trough first, pulling water away from shore, while the long-distance tsunami proceeded crest first.

1. Wave Initiation

Locked in place for centuries, a 750-mile stretch of fault line off Sumatra's coast finally snapped. A magnitude 9 earthquake lifted the seabed by as much as 16 feet. The energy contained in this upsurge of the water column generated the initial wave.

ART BY ROB WOOD (TOP); TSUNAMI SIMULATION BY ERIC L. GEIST, USGS (ABOVE); SPACE IMAGING/CRISP–SINGAPORE (FOLLOWING PAGES)



Tsunami Risks

Coasts Crowded and Vulnerable

The Indian Ocean tsunami, the result of an unusually strong earthquake, served notice that no matter how remote the odds, any shoreline in a tectonically active zone is at risk. And coastal areas with high populations and low elevations are particularly vulnerable to high death tolls. The most tsunami-prone ocean, the Pacific, has seen a whopping 800 in the past century.

Population density within 2 kilometers (1.2 miles) of coastline in areas less than 10 meters (33 feet) in elevation

- More than 75,000 people per square kilometer
- 30,000 to 75,000
- Less than 30,000
- Subduction zone (potential tsunami trigger)

Pacific Northwest-Alaska

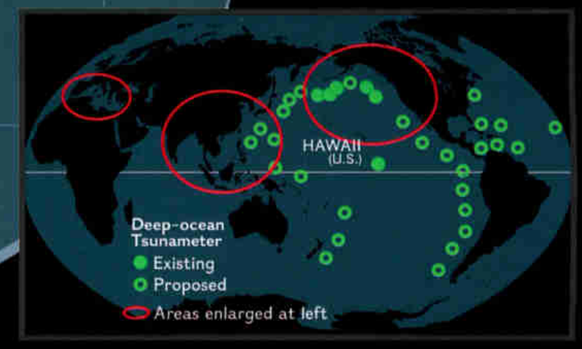
High-magnitude earthquakes off Alaska are among the leading causes of oceanwide tsunamis. Scientists are also monitoring the Cascadia Fault off the Pacific Northwest. When it snaps, lethal waves could hit coastal communities in 15 minutes.

Mediterranean

Accounts of tsunamis go back 3,000 years in the Mediterranean—ten times more prone to damaging waves than the Atlantic. Earthquakes off Greece, Italy, and Turkey have set off most of the waves.

Asia-Pacific

Japan and Indonesia, both with congested coastlines, rate among the world's most tsunami-threatened nations. Some 22 percent of recorded Pacific tsunamis originated off Japan, which has its own sophisticated warning system.



A warning system, established by Pacific Basin countries in the mid-20th century, now includes deep-ocean tsunameters.

SOURCE: LANDSCAN GLOBAL POPULATION DATABASE; OAK RIDGE NATIONAL LABORATORY

NG MAPS

Banda Aceh, Indonesia

Before-and-after satellite images of the north tip of Sumatra show a lush green world (left) now flooded or turned barren brown (right). The tsunami stripped vegetation and buried fields in silt.

Helping Hands Washed almost a mile inland by the tsunami, a green turtle gets a lift from members of the Thai Navy, who rescued the disoriented survivor in a pond north of Phuket. Though wildlife was largely spared in the disaster, debris left behind by the waves now litters natural areas. Off Thailand's Phi Phi Island in the Andaman Sea, a diver (right) joins a large volunteer effort to clean up a coral reef.

Environmental Defense

As reports from tsunami-stricken nations filtered in last December, a pattern emerged: Communities lying behind a fringe of shallow-water mangroves, like parts of India's coastline, or behind an intact coral reef, as in the Maldive Islands, suffered less damage and loss of life than places exposed directly to the brute force of the waves. Mangrove forests and coral reefs had proved their worth once again, helping deflect the enormous energy unleashed by the tsunami.

Not even reefs and forests, though, could escape serious harm off the north end of Sumatra, the landmass nearest the quake's epicenter. There the waves damaged some 60,000 acres of mangroves, 30 percent of the reefs, and 20 percent of the sea grass beds—all vital fish habitat. Now conservation groups are worried that the need for timber to rebuild could lead to clearing hundreds of thousands of acres in Indonesian forests. They're urging that foreign aid include timber donations.

Other grave problems stem from the onslaught of seawater laden with sediments and toxins. Aquifers, the primary source of drinking water, have been contaminated by salt water, raw sewage, oil, and other pollutants. On the coasts of Indonesia and Sri Lanka paddies and farm fields are smothered under a crust of salt and silt. Some areas may never recover, for others irrigation and one or more rainy seasons may be enough to flush out the soil. For now farmers are being encouraged to plant salt-tolerant crops, like pumpkins and kale.

While the massive cleanup and reconstruction efforts proceed, conservationists and community leaders are calling for a slowdown of development and a speedup in planting natural barriers. In recent decades shrimp farms, resorts, and industrial projects have leveled vast tracts of mangroves. The hope now is that a green wall will rise before the crushing waves come again.

—Tom O'Neill

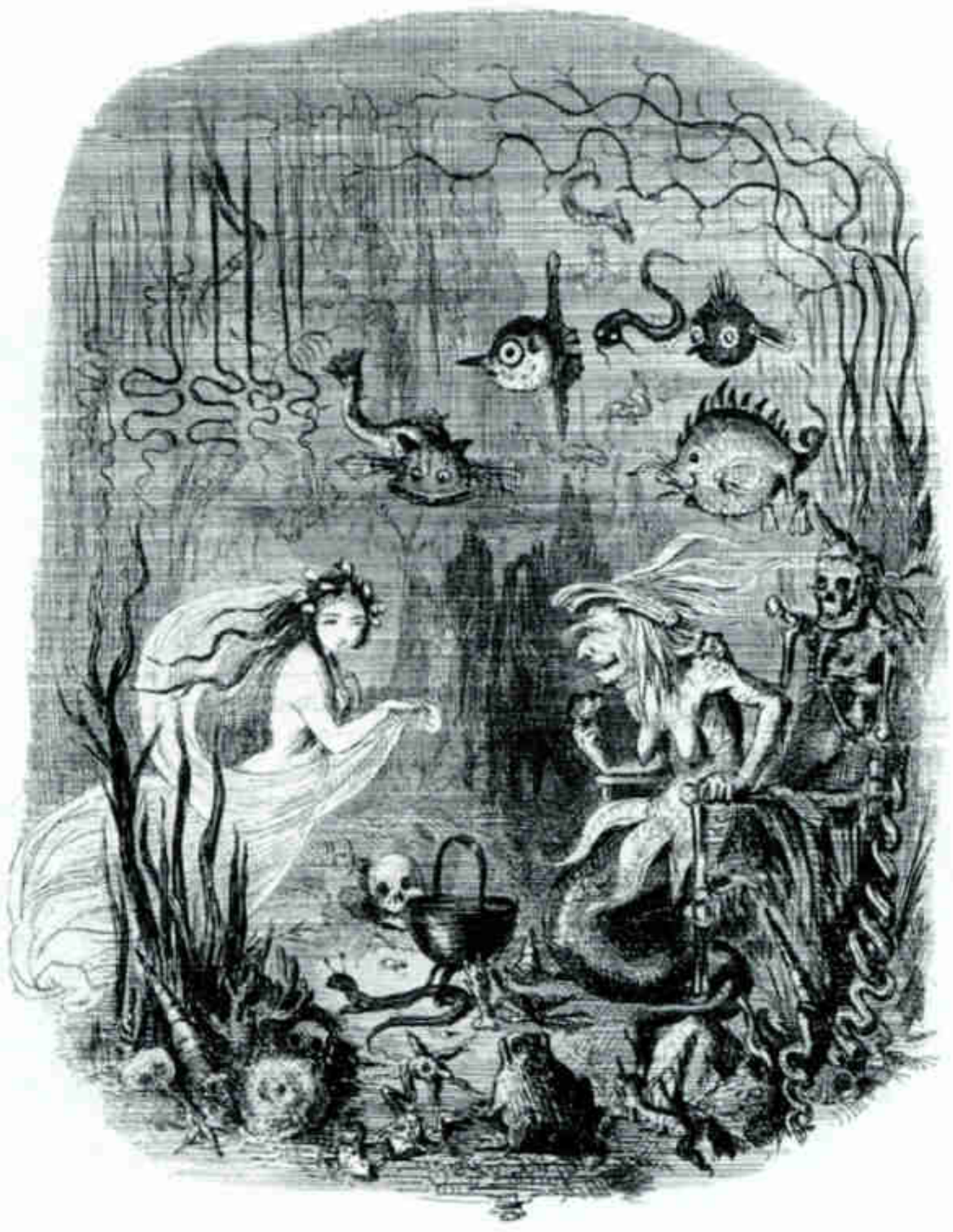
WEBSITE EXCLUSIVE Find more tsunami facts and links to the latest research in our Online Extra at **nationalgeographic.com/magazine/0504.**

SUKREE SUKPLANG, REUTERS/CORBIS (ABOVE); ADREES LATIF, REUTERS/CORBIS (RIGHT)

LITERATURE

Hans Christian Andersen

The peripatetic king of fairy tales turns 200



Hans Christian Andersen would be furious to know that the world remembers him best for a story about an ugly duckling. The intensely insecure Dane desired enduring fame—but not as a children's author.

Born in 1805 in one of Denmark's poorest neighborhoods, Andersen rose to fortune and glory as a literary star.

He conceived his first international hit, the novel *The Improvisatore,* during a trip to Italy. Later journeys through Europe, Turkey, and Scandinavia inspired characters and plots in his novels, travel books, and plays.

Travel fueled Andersen's fame and sharpened his wit, but success never eased his restlessness or self-doubt. Unlucky in love and painfully aware of his modest roots, he never stopped feeling like an outsider.

He sought solace in travel, wandering the world well into his old age. Andersen died in 1875, wealthy but alone. His work endured, however, and today his fairy tales, including "The Little Mermaid" (above), are read in nearly 150 languages, from Abkhazian to Zulu. If he were alive, Andersen probably wouldn't be satisfied. But for millions of readers, he has become what he most desired: a poet of the ages. —*Neil Shea*

GEO NEWS

COMMERCE

■ **Nelson Mandela has filed for trademark protection.** The South African statesman hopes to stop businesses from profiting from his name, "Nelson Mandela," his tribal name, "Rolihlahla," his clan name, "Madiba," and his Robben Island prisoner number, "46664."

ANIMAL KINGDOM

■ **Sperm whales—like human divers—can get the bends.** Researchers studying whale skeletons have discovered bone erosion similar to that suffered by scuba divers who rise to the surface too rapidly. Scientists had long assumed that whales were immune to the bends.

CONSERVATION

■ **Solar power is the law in sunny Spain.** Renovations and new structures are now required to have solar panels incorporated in their designs. The Spanish government estimates that use of a single two-meter solar panel reduces a home's yearly water-heating bill by up to 70 percent. Global demand for solar power has grown at about 25 percent a year, with Japan, Germany, and the U.S. leading the market.

MEDICINE

■ **A blow to drug-resistant bacteria.** Using a molecule called apramycin, scientists have eliminated DNA that allows bacteria like *E. coli* to resist antibiotics. Since apramycin is likely toxic to humans, a more benign molecule is now being sought for use against the growing problem of drug-resistant diseases.

HULTON ARCHIVE/GETTY IMAGES (ABOVE); CORBIS

Sumatran Rhinoceros *(Dicerorhinus sumatrensis)*
Size: Head and body length, 2-3 m; shoulder height, 1-1.5 m **Weight:** 600-950 kg
Habitat: Dense tropical forests, both lowland and highland, in Southeast Asia
Surviving number: Estimated at 300

Photographed by Alain Compost

WILDLIFE AS CANON SEES IT

Hair today, gone tomorrow? A living link with the past, the Sumatran rhinoceros has the ability, under certain conditions, to grow a dense coat of hair like that of the long-extinct woolly rhino. The elusive browser keeps to the dense forest and treasures its solitude. Some humans, however, treasure its horns—an ingredient in traditional medicines, these horns command a high price. Rhino Protection Units are on the job, but the double whammy of poaching and habitat destruction make for a hairy situation indeed. Will the Sumatran rhinoceros survive, or follow its long-lost cousin's footsteps into extinction? Time will tell.

As an active, committed global corporation, we join worldwide efforts to promote awareness of endangered species. Just one way we are working to make the world a better place—today and tomorrow.

Canon has teamed up with the Yellowstone Park Foundation to help scientists protect Yellowstone's wildlife through advanced imaging technologies.

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MEDICINE

The Medici Rise Again

Renaissance secrets solved

One of the richest, most powerful clans in history, Italy's Medici family came to the end of its rule in 1737, when Gian Gastone de' Medici (bust, inset) died without an heir. The famous dynasty of merchants-turned-bankers that financed Renaissance artists such as Leonardo, Michelangelo, and Botticelli, is still dead. It's just not buried anymore.

In May 2004 a team of Italian and American scientists in Florence opened the first of 49 Medici graves slated for exhumation. By running tests such as CT scans and DNA analyses on the remains, the team hopes to learn how the Medici lived, and more importantly, how they died.

"There were a lot of illnesses in epidemic form at the time," says team member Arthur Aufderheide, a paleopathologist at the University of Minnesota. "If we know the pattern of infectious diseases in history, perhaps we might find some clues about treating them today."

PASQUALE SORRENTINO (ABOVE); SCALA/ART RESOURCE, NY

Some Medici suffered from malaria, and historical records say Grand Duke Francesco I died of the disease. But maybe he didn't. Many historians suspect that Francesco and his wife were poisoned by his brother—the next grand duke—in 1587. The family was famous for its cutthroat politics. Machiavelli wrote his cynical primer on sovereignty, *The Prince,* to impress a Medici, and during nearly 300 years in power, the family installed three of their own as popes and married off two daughters to become queens of France.

Now the truth about Francesco's death may finally be established. The scientists exhumed his remains (above, with a bronze memorial plaque also found in his coffin) in December 2004. They soon plan to test his bones for traces of arsenic.

The postmortem exams have already solved some other mysteries. Researchers have diagnosed Cosimo I with a hereditary rheumatic disease, suggesting that his ancestor Piero I, known as Piero the Gouty, may not in fact have suffered from gout. Cosimo's wife, Eleonora di Toledo (left, circa 1545), probably died of malaria, and testing shows she may have had some additional health problems. Scientists investigating her remains found traces of a substance once used to treat syphilis.

In Italy reaction to the Medici exhumations has been mostly positive. The project has enjoyed the support of the Florence museum superintendent and received the blessing of a Medici descendant.

But two of the most famous Medici won't be telling any tales. Lorenzo the Magnificent and Cosimo the Elder are not scheduled to rise from their graves. Moving their fragile marble tombstones is considered too risky. After all, they were carved by Michelangelo.

—Scott Elder

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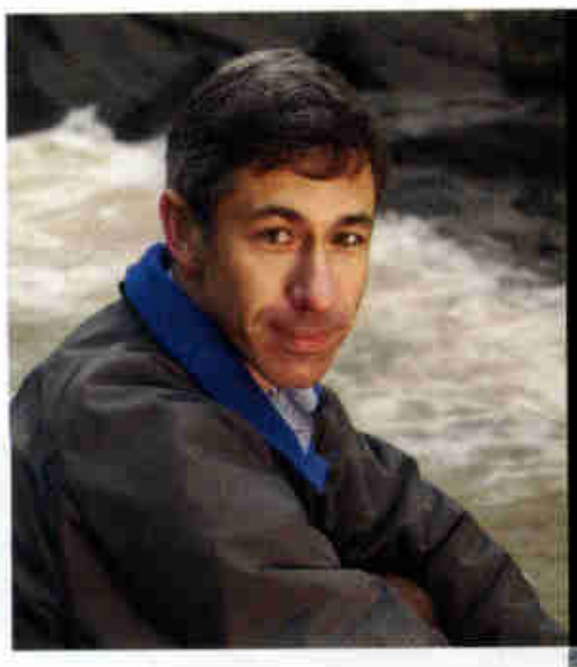

Waves to Remember

Tim Appenzeller *National Geographic Senior Editor for Science*

"Earth science is full of stories," says senior editor Tim Appenzeller, who's been writing those stories for more than 20 years. He consulted with Northwestern University geology professor and tsunami expert Emile Okal to compile the following list of past tsunamis that have made an impact on the world.

NGS PHOTOGRAPHER MARK THIESSEN (TOP LEFT); BETTMANN/CORBIS

1 Minoan, circa 1630 B.C. When a volcano on the Greek island of Santorini exploded, the waves that followed swept Crete—and may have sped the Minoan civilization's demise. The tsunami is said to be a source of the Atlantis myth.

2 Cascadia, 1700 Massive waves originated with a giant earthquake off the coast of the American Pacific Northwest. Some 300-year-old records describing damage from this event have been found in Japan.

3 Lisbon, 1755 The Portuguese capital was laid waste (above) by an offshore earthquake and the waves that followed—events mentioned in Voltaire's *Candide*. Felt as far away as Barbados, it is the only tsunami known to have wrought damage across the Atlantic.

4 Sanriku, 1896 More than 20,000 people died when this tsunami hit Japan's northeast coast with little warning. National Geographic reported on the disaster in September of that year.

5 Aleutian, 1946 Originating off Alaska, the tsunami reached Hawaiian shores within five hours. It spurred the development of the Pacific tsunami warning system.

6 Chile, 1960 A magnitude 9.5 quake—the largest on record—triggered waves that claimed 2,200 lives across the Pacific. This disaster alerted officials to a need for public education about how to respond to tsunamis: Though warnings were posted in Hawaii, spectators came to the waterfront to watch.

7 Papua New Guinea, 1998 *This tsunami* mystified observers when its deadly waves struck along a very limited area of the coastline, killing more than 2,000 people. Scientists have since learned that its cause was an undersea landslide—at the time a little-recognized tsunami trigger. Such landslides are now known to be a threat to many coasts.

WEBSITE EXCLUSIVE

How do rogue waves differ from tsunamis? Our Online Extra has the latest research *at* **nationalgeographic.com/magazine/0504.**

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AMBIEN is indicated for the short-term treatment of insomnia. There is a low occurrence of side effects associated with the short-term use of AMBIEN. The most commonly observed side effects in controlled clinical trials were drowsiness (2%), dizziness (1%), and diarrhea (1%). When you first start taking AMBIEN, use caution in the morning when engaging in activities requiring complete alertness until you know how you will react to this medication. In most instances, memory problems can be avoided if you take AMBIEN only when you are able to get a full night's sleep (7 to 8 hours). As with any sleep medication, do not use alcohol while you are taking AMBIEN. Prescription sleep aids are often taken for 7 to 10 days—or longer as advised by your doctor. All people taking sleep medicines have some risk of becoming dependent on the medicine.

Please see brief summary of prescribing information on adjoining page.

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BRIEF SUMMARY

INDICATIONS AND USAGE

Ambien (zolpidem tartrate) is indicated for the short-term treatment of insomnia. Ambien has been shown to decrease sleep latency and increase the duration of sleep for up to 35 days in controlled clinical studies.

Hypnotics should generally be limited to 7 to 10 days of use, and reevaluation of the patient is recommended if they are to be taken for more than 2 to 3 weeks. Ambien should not be prescribed in quantities exceeding a 1-month supply (see *Warnings*).

CONTRAINDICATIONS

None known.

WARNINGS

Since sleep disturbances may be the presenting manifestation of a physical and/or psychiatric disorder, symptomatic treatment of insomnia should be initiated only after a careful evaluation of the patient. The failure of insomnia to remit after 7 to 10 days of treatment may indicate the presence of a primary psychiatric and/or medical illness which should be evaluated. Worsening of insomnia or the emergence of new thinking or behavior abnormalities may be the consequence of an unrecognized psychiatric or physical disorder. Such findings have emerged during the course of treatment with sedative/hypnotic drugs, including Ambien. Because some of the important adverse effects of Ambien appear to be dose related (see *Precautions* and *Dosage and Administration*), it is important to use the smallest possible effective dose, especially in the elderly.

A variety of abnormal thinking and behavior changes have been reported to occur in association with the use of sedative/hypnotics. Some of these changes may be characterized by decreased inhibition (eg, aggressiveness and extroversion that seemed out of character), similar to effects produced by alcohol and other CNS depressants. Other reported behavioral changes have included bizarre behavior, agitation, hallucinations, and depersonalization. Amnesia and other neuropsychiatric symptoms may occur unpredictably. In primarily depressed patients, worsening of depression, including suicidal thinking, has been reported in association with the use of sedative/hypnotics.

It can rarely be determined with certainty whether a particular instance of the abnormal behaviors listed above is drug induced, spontaneous in origin, or a result of an underlying psychiatric or physical disorder. Nonetheless, the emergence of any new behavioral sign or symptom of concern requires careful and immediate evaluation.

Following the rapid dose decrease or abrupt discontinuation of sedative/hypnotics, there have been reports of signs and symptoms similar to those associated with withdrawal from other CNS-depressant drugs (see *Drug Abuse and Dependence*).

Ambien, like other sedative/hypnotic drugs, has CNS-depressant effects. Due to the rapid onset of action, Ambien should only be ingested immediately prior to going to bed. Patients should be cautioned against engaging in hazardous occupations requiring complete mental alertness or motor coordination such as operating machinery or driving a motor vehicle after ingesting the drug, including potential impairment of the performance of such activities that may occur the day following ingestion of Ambien. Ambien showed additive effects when combined with alcohol and should not be taken with alcohol. Patients should also be cautioned about possible combined effects with other CNS-depressant drugs. Dosage adjustments may be necessary when Ambien is administered with such agents because of the potentially additive effects.

PRECAUTIONS

General

Use in the elderly and/or debilitated patients: Impaired motor and/or cognitive performance after repeated exposure or unusual sensitivity to sedative/hypnotic drugs is a concern in the treatment of elderly and/or debilitated patients. Therefore, the recommended Ambien dosage is 5 mg in such patients (see *Dosage and Administration*) to decrease the possibility of side effects. These patients should be closely monitored.

Use in patients with concomitant illness: Clinical experience with Ambien in patients with concomitant systemic illness is limited. Caution is advisable in using Ambien in patients with diseases or conditions that could affect metabolism or hemodynamic responses. Although studies did not reveal respiratory depressant effects at hypnotic doses of Ambien in normals or in patients with mild to moderate chronic obstructive pulmonary disease (COPD), a reduction in the Total Arousal Index together with a reduction in lowest oxygen saturation and increase in the times of oxygen desaturation below 80% and 90% was observed in patients with mild-to-moderate sleep apnea when treated with Ambien (10 mg) when compared to placebo. However, precautions should be observed if Ambien is prescribed to patients with compromised respiratory function, since sedative/hypnotics have the capacity to depress respiratory drive. Post-marketing reports of respiratory insufficiency, most of which involved patients with pre-existing respiratory impairment, have been received. Data in end-stage renal failure patients repeatedly treated with Ambien did not demonstrate drug accumulation or alterations in pharmacokinetic parameters. No dosage adjustment in renally impaired patients is required; however, these patients should be closely monitored (see *Pharmacokinetics*). A study in subjects with hepatic impairment did reveal prolonged elimination in this group; therefore, treatment should be initiated with 5 mg in patients with hepatic compromise, and they should be closely monitored.

Use in depression: As with other sedative/hypnotic drugs, Ambien should be administered with caution to patients exhibiting signs or symptoms of depression. Suicidal tendencies may be present in such patients and protective measures may be required. Intentional overdosage is more common in this group of patients; therefore, the least amount of drug that is feasible should be prescribed for the patient at any one time.

Information for patients: Patient information is printed in the complete prescribing information.

Laboratory tests: There are no specific laboratory tests recommended.

Drug interactions

CNS-active drugs: Ambien was evaluated in healthy volunteers in single-dose interaction studies for several CNS drugs. A study involving haloperidol and zolpidem revealed no effect of haloperidol on the pharmacokinetics or pharmacodynamics of zolpidem. Imipramine in combination with zolpidem produced no pharmacokinetic interaction other than a 20% decrease in peak levels of imipramine, but there was an additive effect of decreased alertness. Similarly, chlorpromazine in combination with zolpidem produced no pharmacokinetic interaction, but there was an additive effect of decreased alertness and psychomotor performance. The lack of a drug interaction following single-dose administration does not predict a lack following chronic administration.

An additive effect on psychomotor performance between alcohol and zolpidem was demonstrated.

A single-dose interaction study with zolpidem 10 mg and fluoxetine 20 mg at steady-state levels in male volunteers did not demonstrate any clinically significant pharmacokinetic or pharmacodynamic interactions. When multiple doses of zolpidem and fluoxetine at steady-state concentrations were evaluated in healthy females, the only significant change was a 17% increase in the zolpidem half-life. There was no evidence of an additive effect in psychomotor performance.

Following five consecutive nightly doses of zolpidem 10 mg in the presence of sertraline 50 mg (17 consecutive daily doses, at 7:00 am, in healthy female volunteers), zolpidem C_{max} was significantly higher (43%) and T_{max} was significantly decreased (53%). Pharmacokinetics of sertraline and N-desmethylsertraline were unaffected by zolpidem.

Since the systematic evaluations of Ambien in combination with other CNS-active drugs have been limited, careful consideration should be given to the pharmacology of any CNS-active drug to be used with zolpidem. Any drug with CNS-depressant effects could potentially enhance the CNS-depressant effects of zolpidem.

Drugs that affect drug metabolism via cytochrome P450: A randomized, double-blind, crossover interaction study in ten healthy volunteers between itraconazole (200 mg once daily for 4 days) and a single dose of zolpidem (10 mg) given 5 hours after the last dose of itraconazole resulted in a 34% increase in $AUC_{0-\infty}$ of zolpidem. There were no significant pharmacodynamic effects of zolpidem on subjective drowsiness, postural sway, or psychomotor performance.

A randomized, placebo-controlled, crossover interaction study in eight healthy female volunteers between 5 consecutive daily doses of rifampin (600 mg) and a single dose of zolpidem (20 mg) given 17 hours after the last dose of rifampin showed significant reductions of the AUC (–73%), C_{max} (–58%), and $T_{1/2}$ (–36%) of zolpidem together with significant reductions in the pharmacodynamic effects of zolpidem.

Other drugs: A study involving cimetidine/zolpidem and ranitidine/zolpidem combinations revealed no effect of either drug on the pharmacokinetics or pharmacodynamics of zolpidem. Zolpidem had no effect on digoxin kinetics and did not affect prothrombin time when given with warfarin in normal subjects. Zolpidem's sedative/hypnotic effect was reversed by flumazenil; however, no significant alterations in zolpidem pharmacokinetics were found.

Drug/Laboratory test interactions: Zolpidem is not known to interfere with commonly employed clinical laboratory tests. In addition, clinical data indicate that zolpidem does not cross-react with benzodiazepines, opiates, barbiturates, cocaine, cannabinoids, or amphetamines in two standard urine drug screens.

Carcinogenesis, mutagenesis, impairment of fertility

Carcinogenesis: Zolpidem was administered to rats and mice for 2 years at dietary dosages of 4, 18, and 80 mg/kg/day. In mice, these doses are 26 to 520 times or 2 to 35 times the maximum 10-mg human dose on a mg/kg or mg/m² basis, respectively. In rats these doses are 43 to 876 times or 6 to 115 times the maximum 10-mg human dose on a mg/kg or mg/m² basis, respectively. No evidence of carcinogenic potential was observed in mice. Renal liposarcomas were seen in 4/100 rats (3 males, 1 female) receiving 80 mg/kg/day and a renal lipoma was observed in one male rat at the 18 mg/kg/day dose. Incidence rates of lipoma and liposarcoma for zolpidem were comparable to those seen in historical controls and the tumor findings are thought to be a spontaneous occurrence.

Mutagenesis: Zolpidem did not have mutagenic activity in several tests including the Ames test, genotoxicity in mouse lymphoma cells in vitro, chromosomal aberrations in cultured human lymphocytes, unscheduled DNA synthesis in rat hepatocytes in vitro, and the micronucleus test in mice.

Impairment of fertility: In a rat reproduction study, the high dose (100 mg base/kg) of zolpidem resulted in irregular estrus cycles and prolonged precoital intervals, but there was no effect on male or female fertility after daily oral doses of 4 to 100 mg base/kg or 5 to 130 times the recommended human dose in mg/m². No effects on any other fertility parameters were noted.

Pregnancy

Teratogenic effects: Category B. Studies to assess the effects of zolpidem on human reproduction and development have not been conducted.

Teratology studies were conducted in rats and rabbits.

In rats, adverse maternal and fetal effects occurred at 20 and 100 mg base/kg and included dose-related maternal lethargy and ataxia and a dose-related trend to incomplete ossification of fetal skull bones.

In rabbits, dose-related maternal sedation and decreased weight gain occurred at all doses tested. At the high dose, 16 mg base/kg, there was an increase in postimplantation fetal loss and underossification of sternebrae in viable fetuses.

This drug should be used during pregnancy only if clearly needed.

Nonteratogenic effects: Studies to assess the effects on children whose mothers took zolpidem during pregnancy have not been conducted. However, children born of mothers taking sedative/hypnotic drugs may be at some risk for withdrawal symptoms from the drug during the postnatal period. In addition, neonatal flaccidity has been reported in infants born of mothers who received sedative/hypnotic drugs during pregnancy.

Labor and delivery: Ambien has no established use in labor and delivery.

Nursing mothers: Studies in lactating mothers indicate that between 0.004 and 0.019% of the total administered dose is excreted into milk, but the effect of zolpidem on the infant is unknown.

The use of Ambien in nursing mothers is not recommended.

Pediatric use: Safety and effectiveness in pediatric patients below the age of 18 have not been established.

Geriatric use: A total of 154 patients in U.S. controlled clinical trials and 897 patients in non-U.S. clinical trials who received zolpidem were ≥60 years of age. For a pool of U.S. patients receiving zolpidem at doses of ≤10 mg or placebo, there were three adverse events occurring at an incidence of at least 3% for zolpidem and for which the zolpidem incidence was at least twice the placebo incidence (ie, they could be considered drug related).

Adverse Event	Zolpidem	Placebo
Dizziness	3%	0%
Drowsiness	5%	2%
Diarrhea	3%	1%

A total of 30/1,959 (1.5%) non-U.S. patients receiving zolpidem reported falls, including 28/30 (93%) who were ≥70 years of age. Of these 28 patients, 23 (82%) were receiving zolpidem doses >10 mg. A total of 24/1,959 (1.2%) non-U.S. patients receiving zolpidem reported confusion, including 18/24 (75%) who were ≥70 years of age. Of these 18 patients, 14 (78%) were receiving zolpidem doses >10 mg.

ADVERSE REACTIONS

Associated with discontinuation of treatment: Approximately 4% of 1,701 patients who received zolpidem at all doses (1.25 to 90 mg) in U.S. premarketing clinical trials discontinued treatment because of an adverse clinical event. Events most commonly associated with discontinuation from U.S. trials were daytime drowsiness (0.5%), dizziness (0.4%), headache (0.5%), nausea (0.6%), and vomiting (0.5%).

Approximately 4% of 1,959 patients who received zolpidem at all doses (1 to 50 mg) in similar foreign trials discontinued treatment because of an adverse event. Events most commonly associated with discontinuation from these trials were daytime drowsiness (1.1%), dizziness/vertigo (0.8%), amnesia (0.5%), nausea (0.5%), headache (0.4%), and falls (0.4%).

Data from a clinical study in which selective serotonin reuptake inhibitor- (SSRI) treated patients were given zolpidem revealed that four of the seven discontinuations during double-blind treatment with zolpidem (n=95) were associated with impaired concentration, continuing or aggravated depression, and manic reaction; one patient treated with placebo (n=97) was discontinued after an attempted suicide.

Incidence in controlled clinical trials

Most commonly observed adverse events in controlled trials: During short-term treatment (up to 10 nights) with Ambien at doses up to 10 mg, the most commonly observed adverse events associated with the use of zolpidem and seen at statistically significant differences from placebo-treated patients were drowsiness (reported by 2% of zolpidem patients), dizziness (1%), and diarrhea (1%). During longer-term treatment (28 to 35 nights) with zolpidem at doses up to 10 mg, the most commonly observed adverse events associated with the use of zolpidem and seen at statistically significant differences from placebo-treated patients were dizziness (5%) and drugged feelings (3%).

Treatment-emergent adverse experiences in placebo-controlled clinical trials: The following are treatment-emergent adverse events from U.S. placebo-controlled clinical trials. Data are limited to data from doses up to and including 10 mg. In short-term trials, events seen in zolpidem patients (n=685) at an incidence equal to 1% or greater compared to placebo (n=473) were: headache (7% vs 6% for placebo), drowsiness (2% vs 0%), dizziness (1% vs

0%), nausea (2% vs 3%), diarrhea (1% vs 0%), and myalgia (1% vs 2%). In long-term clinical trials, events seen in zolpidem patients (n=152) at an incidence of 1% or greater compared to placebo (n=161) were: dry mouth (3% vs 1% for placebo), allergy (4% vs 1%), back pain (3% vs 2%), influenza-like symptoms (2% vs 0%) , chest pain (1% vs 0%), fatigue (1% vs 2%), palpitation (2% vs 0%), headache (19% vs 22%), drowsiness (8% vs 5%), dizziness (5% vs 1%), lethargy (3% vs 1%), drugged feeling (3% vs 0%), lightheadedness (2% vs 1%), depression (2% vs 1%), abnormal dreams (1% vs 0%), amnesia (1% vs 0%), anxiety (1% vs 1%), nervousness (1% vs 3%), sleep disorder (1% vs 0%), nausea (6% vs 6%), dyspepsia (5% vs 6%), diarrhea (3% vs 2%), abdominal pain (2% vs 2%), constipation (2% vs 1%), anorexia (1% vs 1%), vomiting (1% vs 1%), infection (1% vs 1%), myalgia (7% vs 7%), arthralgia (4% vs 4%), upper respiratory infection (5% vs 6%), sinusitis (4% vs 2%), pharyngitis (3% vs 1%), rhinitis (1% vs 3%), rash (2% vs 1%), and urinary tract infection (2% vs 2%).

Dose relationship for adverse events: There is evidence from dose comparison trials suggesting a dose relationship for many of the adverse events associated with zolpidem use, particularly for certain CNS and gastrointestinal adverse events.

Adverse events are further classified and enumerated in order of decreasing frequency using the following definitions: frequent adverse events are defined as those occurring in greater than 1/100 subjects; infrequent adverse events are those occurring in 1/100 to 1/1,000 patients; rare events are those occurring in less than 1/1,000 patients.

Frequent: abdominal pain, abnormal dreams, allergy, amnesia, anorexia, anxiety, arthralgia, asthenia, ataxia, back pain, chest pain, confusion, constipation, depression, diarrhea, diplopia, dizziness, drowsiness, drugged feeling, dry mouth, dyspepsia, euphoria, fatigue, headache, hiccup, infection, influenza-like symptoms, insomnia, lethargy, lightheadedness, myalgia, nausea, nervousness, palpitation, sleep disorder, vertigo, vision abnormal, vomiting.

Infrequent: abnormal hepatic function, agitation, arthritis, bronchitis, cerebrovascular disorder, coughing, cystitis, decreased cognition, detached, difficulty concentrating, dysarthria, dysphagia, dyspnea, edema, emotional lability, eye irritation, eye pain, falling, fever, flatulence, gastroenteritis, hallucination, hyperglycemia, hypertension, hypoesthesia, illusion, increased SGPT, increased sweating, leg cramps, malaise, menstrual disorder, migraine, pallor, paresthesia, postural hypotension, pruritus, scleritis, sleeping (after daytime dosing), speech disorder, stupor, syncope, tachycardia, taste perversion, thirst, tinnitus, trauma, tremor, urinary incontinence, vaginitis.

Rare: abdominal body sensation, abnormal accommodation, abnormal gait, abnormal thinking, abscess, acne, acute renal failure, aggressive reaction, allergic reaction, allergy aggravated, altered saliva, anaphylactic shock, anemia, angina pectoris, apathy, appetite increased, arrhythmia, arteritis, arthrosis, bilirubinemia, breast fibroadenosis, breast neoplasm, breast pain, bronchospasm, bullous eruption, circulatory failure, conjunctivitis, corneal ulceration, decreased libido, delusion, dementia, depersonalization, dermatitis, dysphasia, dysuria, enteritis, epistaxis, eructation, esophagospasm, extrasystoles, face edema, feeling strange, flushing, furunculosis, gastritis, glaucoma, gout, hemorrhoids, herpes simplex, herpes zoster, hot flashes, hypercholesteremia, hyperhemoglobinemia, hyperlipidemia, hypertension aggravated, hypokinesia, hypotension, hypotonia, hypoxia, hysteria, impotence, increased alkaline phosphatase, increased BUN, increased ESR, increased saliva, increased SGOT, injection-site inflammation, intestinal obstruction, intoxicated feeling, lacrimation abnormal, laryngitis, leukopenia, lymphadenopathy, macrocytic anemia, manic reaction, micturition frequency, muscle weakness, myocardial infarction, neuralgia, neuritis, neuropathy, neurosis, nocturia, otitis externa, otitis media, pain, panic attacks, paresis, parosmia, periorbital edema, personality disorder, phlebitis, photopsia, photosensitivity reaction, pneumonia, polyuria, pulmonary edema, pulmonary embolism, purpura, pyelonephritis, rectal hemorrhage, renal pain, restless legs, rigors, sciatica, somnambulism, suicide attempts, tendinitis, tenesmus, tetany, thrombosis, tolerance increased, tooth caries, urinary retention, urticaria, varicose veins, ventricular tachycardia, weight decrease, yawning.

DRUG ABUSE AND DEPENDENCE

Controlled substance: Schedule IV.

Abuse and dependence: Studies of abuse potential in former drug abusers found that the effects of single doses of zolpidem tartrate 40 mg were similar, but not identical, to diazepam 20 mg, while zolpidem tartrate 10 mg was difficult to distinguish from placebo.

Sedative/hypnotics have produced withdrawal signs and symptoms following abrupt discontinuation. These reported symptoms range from mild dysphoria and insomnia to a withdrawal syndrome that may include abdominal and muscle cramps, vomiting, sweating, tremors, and convulsions. The U.S. clinical trial experience from zolpidem does not reveal any clear evidence for withdrawal syndrome. Nevertheless, the following adverse events included in DSM-III-R criteria for uncomplicated sedative/hypnotic withdrawal were reported at an incidence of ≤1% during U.S. clinical trials following placebo substitution occurring within 48 hours following last zolpidem treatment: fatigue, nausea, flushing, lightheadedness, uncontrolled crying, emesis, stomach cramps, panic attack, nervousness, and abdominal discomfort. Rare post-marketing reports of abuse, dependence and withdrawal have been received.

Individuals with a history of addiction to, or abuse of, drugs or alcohol are at increased risk of habituation and dependence; they should be under careful surveillance when receiving any hypnotic.

OVERDOSAGE

Signs and symptoms: In European postmarketing reports of overdose with zolpidem alone, impairment of consciousness has ranged from somnolence to light coma, with one case each of cardiovascular and respiratory compromise. Individuals have fully recovered from zolpidem tartrate overdoses up to 400 mg (40 times the maximum recommended dose). Overdose cases involving multiple CNS-depressant agents, including zolpidem, have resulted in more severe symptomatology, including fatal outcomes.

Recommended treatment: General symptomatic and supportive measures should be used along with immediate gastric lavage where appropriate. Intravenous fluids should be administered as needed. Flumazenil may be useful. Respiration, pulse, blood pressure, and other appropriate signs should be monitored and general supportive measures employed. Sedating drugs should be withheld following zolpidem overdosage. Zolpidem is not dialyzable.

The possibility of multiple drug ingestion should be considered.

Rx only

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FLORES/DMANISI HOMININS

Reanimator

An artist gives new life to old bones

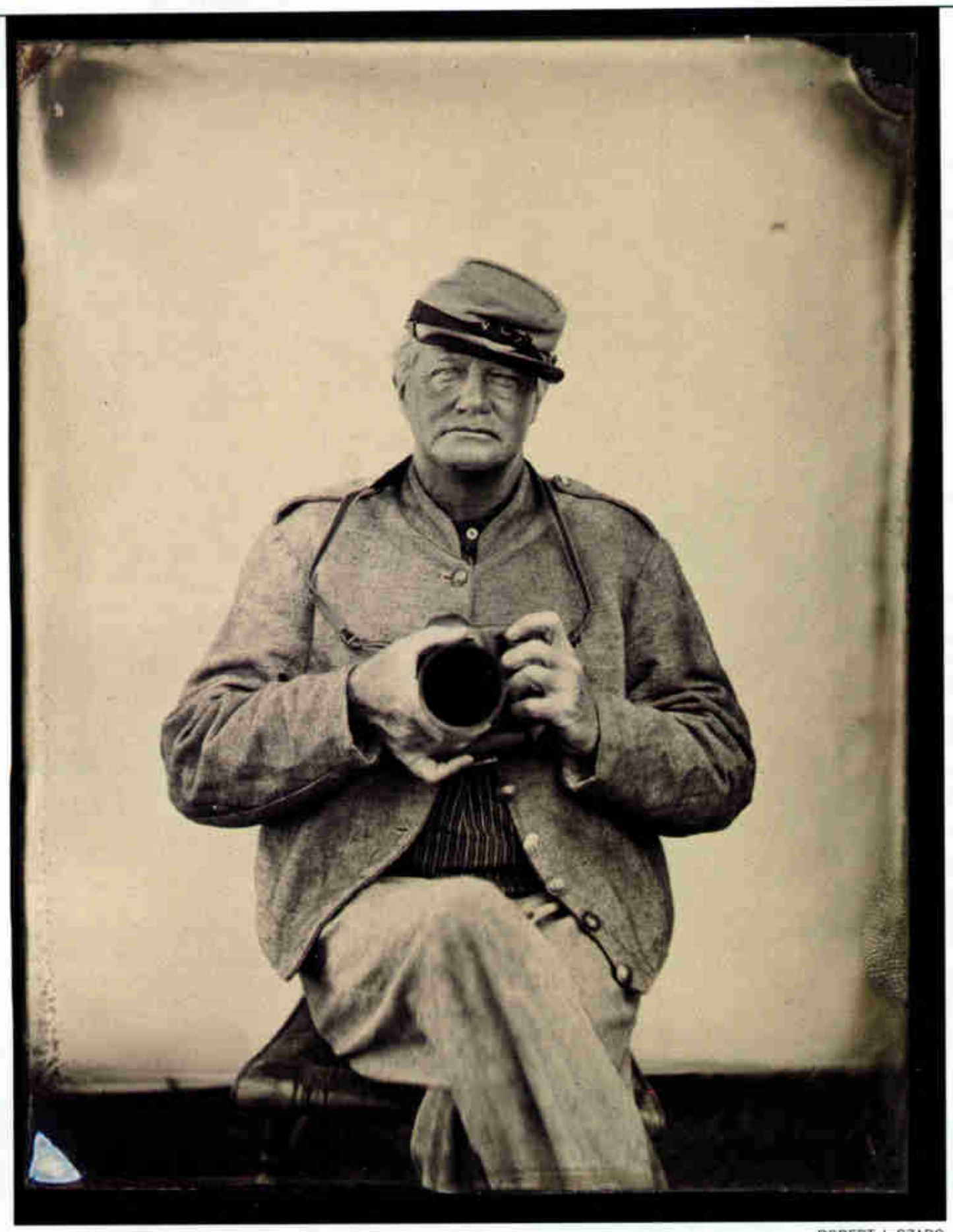
Many people see a skull and think of death, but artist **John Gurche** thinks about how to bring it to life. For this month's articles on early humans, John reconstructed the heads of four prehistoric hominins. To re-create the face of a tiny female found in Indonesia (right), he began with a copy of her skull. Using clay, he sculpted layers of fat and facial muscles (stages shown below). Then, after casting the head in silicone, he tinted the skin a realistic shade. But the face "really starts coming to life when I add the eyes," John says.

John's models are based on more than artistry. He's dissected human and ape cadavers to understand soft tissue structures. "The work can be aesthetically powerful," he says, "only if the science behind it is solid."

GNMENT

COVERING THE WORLD

JOHN GURCHE (INSETS); REBECCA HALE, NGS STAFF



ROBERT J. SZABO

CIVIL WAR BATTLEFIELDS

How to Dress for War

"Don't worry if you drool on it," veteran reenactor Rob Hodge told **Michael Melford** (above) as he handed the photographer a smelly, scratchy Confederate uniform that hadn't been washed for years—if ever. "The dirtier the clothes the better." The two were getting ready to join thousands of other "soldiers" reenacting the bloody battles fought at Spotsylvania Court House, Virginia, in the spring of 1864.

"They prepare for battle 365 days a year," Michael says of Hodge and his fellow reenactors. "When they show up, they look like they've stepped out of a time machine set 140 years ago."

To get into character, many of the thousands of Civil War reenactors in the U.S. grow beards for years, invest thousands of dollars in reproduction uniforms and weapons, and eat little. Very little. During reenactments they live as the soldiers did, sleeping on the ground and subsisting on stale bread or nothing at all. "Civil War soldiers were skin and bones," Michael says. "If you're a hard-core reenactor, you're not going to be puffy."

Michael was not that hard-core when it came to creature comforts—he slumbered comfortably at a hotel and never missed a meal. Still, he says, "I walked away wanting to be a member of this club."

WORLDWIDE

GUANTANAMO BAY

Confinement, says writer **Jeannie Ralston,** defines life at Guantanamo Bay—and not just for the detainees. Separated from the rest of Cuba by heavily guarded barriers, "Gitmo" is the only U.S. base on hostile territory. With few exceptions, no one passes in or out of the base's gates. "To get to Guantanamo City, a few miles from the base," Jeannie says, "you have to fly to Jamaica, then fly to Havana, and then take a bus." Even the geography contributes to the sense of being trapped. "The bay is ringed by mountains, so you don't see any towns," Jeannie says. And unlike much of Cuba, Guantanamo's climate is dry. It has a "very lonely feel," says photographer **Robb Kendrick,** who is married to Jeannie. "The ground is powder white. There are no trees, no sense of greenery. It's kind of a depressing place."

Although Robb had broader access than many journalists, he was closely watched. One day in Camp 4, where cooperative detainees are housed, a prisoner asked Robb what newspaper he was from. "I didn't know whether I could or even should answer him," Robb says. "I didn't know if answering would get me kicked out." Finally, he responded, "NATIONAL GEOGRAPHIC." The prisoner nodded in recognition —the GEOGRAPHIC is one of the few publications detainees are allowed to read.

TALES FROM THE FIELD Find more stories from our authors and photographers, including their best, worst, and quirkiest experiences, at **nationalgeographic.com/magazine/0504.**

EMERGING EXPLORER TIM SAMARAS With winds roaring, debris flying, and a ferocious funnel heading straight at him, Tim Samaras turns and runs—toward it. His mission, to place a probe in the tornado's path that measures barometric pressure, humidity, temperature, wind speed, and direction. Information that unravels an unsolved mystery of the atmosphere and helps forecasters give earlier warnings. Current warning time averages only 13 minutes, so for residents caught in a twister's path, every extra minute can be a lifesaver. Tim's final job—get out of the way. Fast.

Chasing nature's twisted mystery

"IT ALL STARTED WHEN I WAS SIX YEARS OLD and saw that fantastic tornado in The Wizard of Oz. *Later, as an engineer, I had the chance to design the next generation tornado weather probe. There's so much we don't know about how and why these storms develop. So when data from my probes helps to finally put the puzzle together, it's exciting. Of course you have to be prepared for anything—roads ripped right off the ground... fields mowed down...entire towns sucked away...I'm willing to take some risks to get the data, it's the only way."*
—Tim Samaras, research engineer and tornado scientist

we see

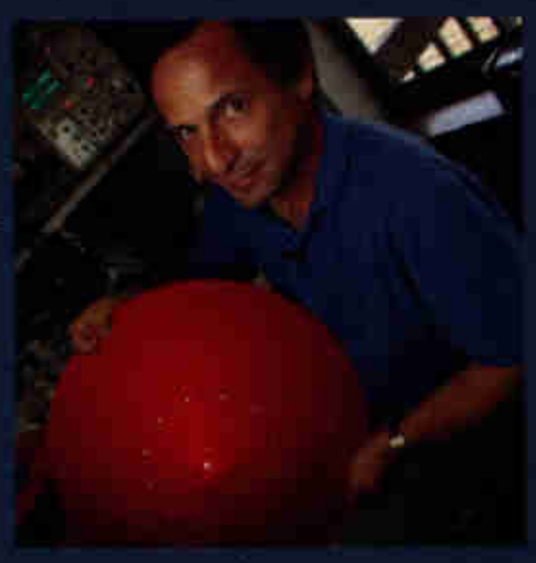
nothing small about them.

Kids are so full of potential. They can become anything they dream, and with the right teachers and the right tools, they will. We stand in awe of kids and their potential. We're inspired to create software that helps them reach it. microsoft.com/potential

Your potential. Our passion.™

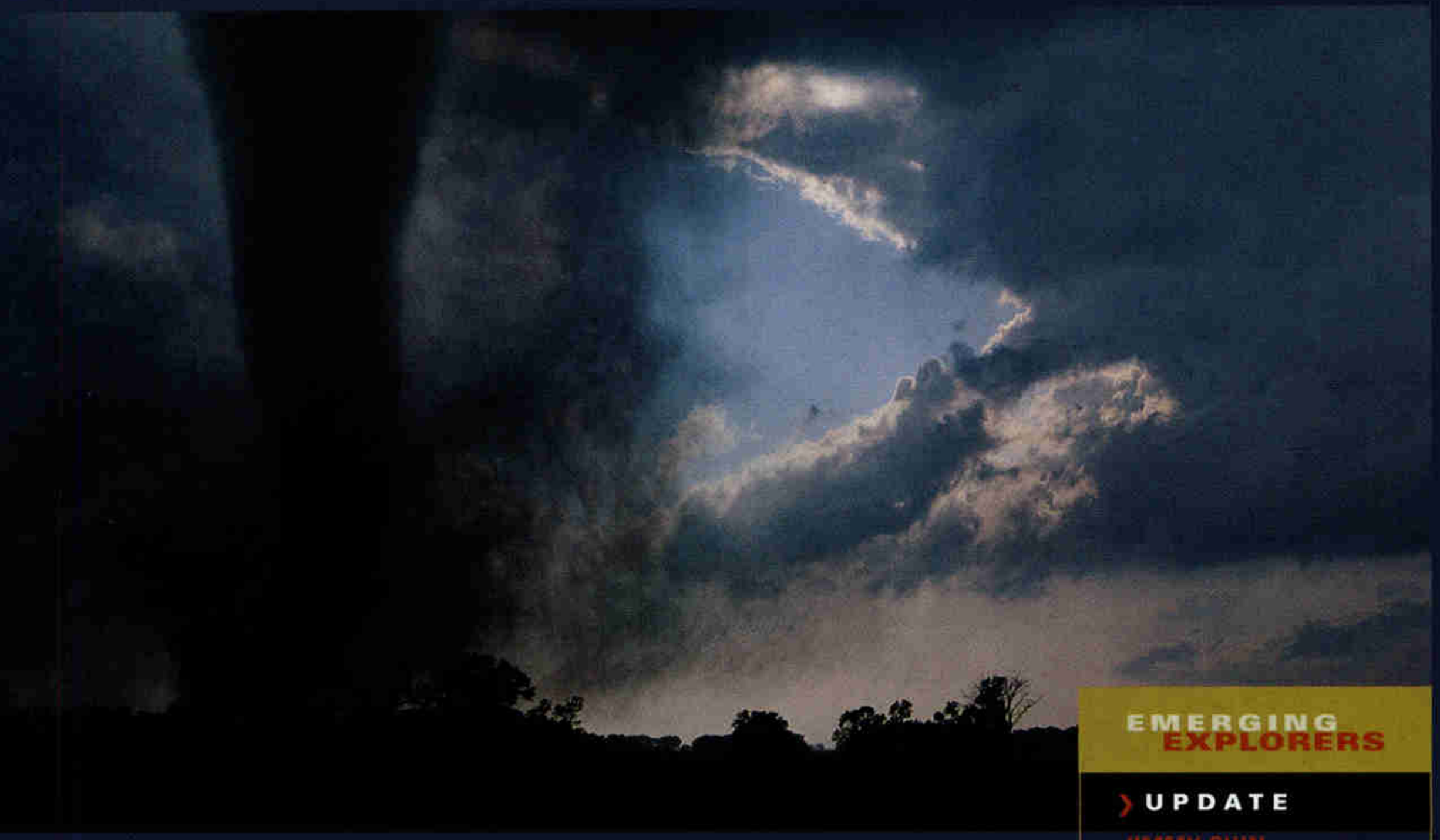
Microsoft

EMERGING EXPLORERS PROGRAM



Manchester Monster

With a funnel cloud licking his bumper, Tim was only 100 yards and 60 seconds ahead of a deadly F4 tornado. He deployed his probe as the twister's 200-plus mile an hour winds devoured a South Dakota farmhouse and hurled telephone poles through the air. Amazingly, his probe survived the direct hit, its downloaded data showing the biggest pressure drop ever recorded (100 millibars), like stepping into an elevator and hurtling up 1,000 feet in ten seconds.



Since 2003, the National Geographic Emerging Explorers program has identified and supported rising talents who are pioneering discoveries in a wide range of fields. Recognizing the crucial role technology plays in exploration, Microsoft has supported this program since its inception and is proud to continue their commitment by helping an extraordinary new generation of explorers realize their potential.

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EMERGING EXPLORERS

› UPDATE

JIMMY CHIN
—Climber, Photographer, 2003 Grantee

Grantee Jimmy returned to Mount Everest traveling from Kathmandu to the summit, shooting production stills and a documentary video for Universal Studios' upcoming film on Everest. Loaded with heavy camera equipment, climbing and shooting nonstop, he sums up the trip in a word: "intense."

Visit nationalgeographic.com/emerging to see and hear the Emerging Explorers.

Photographs: Carsten Peter

Who Knew?

GENETICS

Meaty Chickens

Consumers demand bigger breasts

This has become a world of chickens. It's Planet Pollo. It's an astonishing triumph for the descendants of the humble creature called the red jungle fowl *(Gallus gallus)*.

Before World War II, chicken was fairly expensive, hardly a staple in the developed world. The political promise of "a chicken in every pot" seemed far-fetched. But breeders realized that if they could hybridize corn, they could do a similar thing with chickens, and today chicken is the number one meat in the U.S.

The demand for processed chicken parts along with a taste for breast meat drives the commercial industry. In the '80s, 10 percent of a typical chicken's weight was breast meat, but that has risen to 21 percent, says John Hardiman, geneticist with Cobb-Vantress in Siloam Springs, Arkansas. "I think for sure we're going to see 30 percent, which is probably a little bit closer to where the turkeys are these days," Hardiman says.

His company is one of a handful of major firms that still raise breeder chicks for the commercial market. Billions of chickens come from a few original populations. Cobb's big product is a hybrid chick with lots of breast meat, high livability, and excellent feed efficiency.

But with all those chickens coming from a limited number of breeders, you can imagine the potential for the chickens to lose genetic diversity. That, in turn, could invite a biological disaster. Pathogens could sweep through the chicken industry.

So far chickens have managed to retain a surprising amount of genetic diversity. Therein lies a possible insight into the way genes evolve.

Paul Siegel, a Virginia Tech poultry geneticist, started an experiment in 1957 in which he plucked the largest and smallest chickens from an original hatch. He bred them in two separate lines, such that his large chickens over time became larger, close to four pounds after eight weeks, while his small ones became ever more petite, with an eight-week weight of less than half a pound. From a common genetic origin he wound up, after nearly half a century and 47 generations of chickens, with a ten-fold difference in size.

His biggest fear never materialized: "We should have run out of genetic variation," he says. "We haven't. Genetic progress seems to level off for a couple of generations and then responds to selection again."

Siegel's theory: "I think the mutation rate is a lot higher than we'd thought." We tend to think of mutation as bad, but in Siegel's experiment it rescues the chickens from a genetic dead end. The biggest limitation is physiological: His big chickens will eat themselves to death if their feed isn't restricted, and some of his littlest chickens don't eat enough and can die from anorexia.

One thing's for sure, though: When they turn into chicken nuggets, they're going to look exactly the same.

—Joel Achenbach
WASHINGTON POST STAFF WRITER

WEBSITE EXCLUSIVE For more on genetic diversity, and for links to Joel Achenbach's work, go to Resources at **nationalgeographic.com/magazine/0504.**

PHOTO ILLUSTRATION BY CARY WOLINSKY

COULD THIS BE THE FACE—SHOWN LIFE-SIZE—OF A LOST HUMAN SPECIES THAT STOOD THREE FEET TALL AND INHABITED AN ISOLATED ISLAND WORLD?

Synthetic skin and hair bring to life the cast of an 18,000-year-old skull of a female. Her remains were found with those of six other tiny beings on Flores, where they hunted creatures from giant rats to Komodo dragons and made stone tools—all with brains smaller than a chimp's.

▶ See the skull morph into the face above at **nationalgeographic.com/magazine/0504.**

H. FLORESIENSIS RECONSTRUCTION BY JOHN GURCHE

the People Time Forgot

FLORES FIND

Miniature beings with skulls far smaller than our own sprang from an ancient line of human ancestors. How did they reach—and survive on—a remote Indonesian island?

BY MIKE MORWOOD · THOMAS SUTIKNA · RICHARD ROBERTS
PHOTOGRAPHS BY KENNETH GARRETT
ART BY LARS GRANT-WEST

At first we thought it was a child, perhaps three years old. But a closer look showed that the tiny, fragile bones we had just laid bare in a spacious cave on the Indonesian island of Flores belonged to a full-grown adult just over three feet tall.

Had we simply found a modern human stunted by disease or malnutrition? No. The bones looked primitive, and other remains from Liang Bua, which means "cool cave" in the local Manggarai language, showed that this skeleton wasn't unique. It was typical of a whole population of tiny beings who once lived on this remote island. We had discovered a new kind of human.

Back in the lab, where we analyzed the bones and other artifacts, the full dimensions of what we had discovered began to emerge. This tiny human relative, whom we nicknamed Hobbit, lived just 18,000 years ago, a time when modern humans—people like us—were on the march around the globe. Yet it looked more like a diminutive version of human ancestors a hundred times older, from the other end of Asia (see "Family Ties," page 16).

We had stumbled on a lost world: pygmy survivors from an earlier era, hanging on far from the main currents of human prehistory. Who were they? And what does this lost relative tell us about our evolutionary past?

A 220-mile-long island between mainland Asia and Australia, Flores was never connected by land bridges to either continent. Even at times of low sea level, island-hopping to Flores from mainland Asia involved sea crossings of up to 15 miles. Before modern humans began ferrying animals such as monkeys, pigs, and dogs to the island about 4,000 years ago, the only land mammals to reach it were stegodonts (extinct elephant ancestors) and rodents—the former by swimming and the latter by hitching a ride on flotsam. No people could have reached Flores until modern humans came along, with the brainpower needed to build boats. Or so most scientists believed.

Yet in the 1950s and '60s Theodor Verhoeven, a priest and part-time archaeologist, had found signs of an early human presence. In the Soa Basin of Flores he found stone artifacts near stegodont fossils, thought to be around 750,000 years

old. *Homo erectus*, an archaic hominin (a term for humans and their relatives), was known to have lived on nearby Java at least 1.5 million years ago, so Verhoeven concluded that *erectus* somehow crossed the sea to Flores.

As an amateur making extraordinary claims, Verhoeven failed to persuade the archaeological establishment. In the 1990s, however, other researchers used modern techniques to date tools from the Soa Basin to about 840,000 years ago. Verhoeven was right: Human ancestors had reached Flores long before modern humans landed. But no actual remains of Flores's earlier inhabitants had ever turned up.

So we went looking, focusing on Liang Bua, in the uplands of western Flores. By September 2003 our team of Indonesian and Australian researchers, assisted by 35 Manggarai workers, had dug 20 feet into the cave floor. Younger layers were rich in stone artifacts and animal bones, but by this point the dig seemed played out.

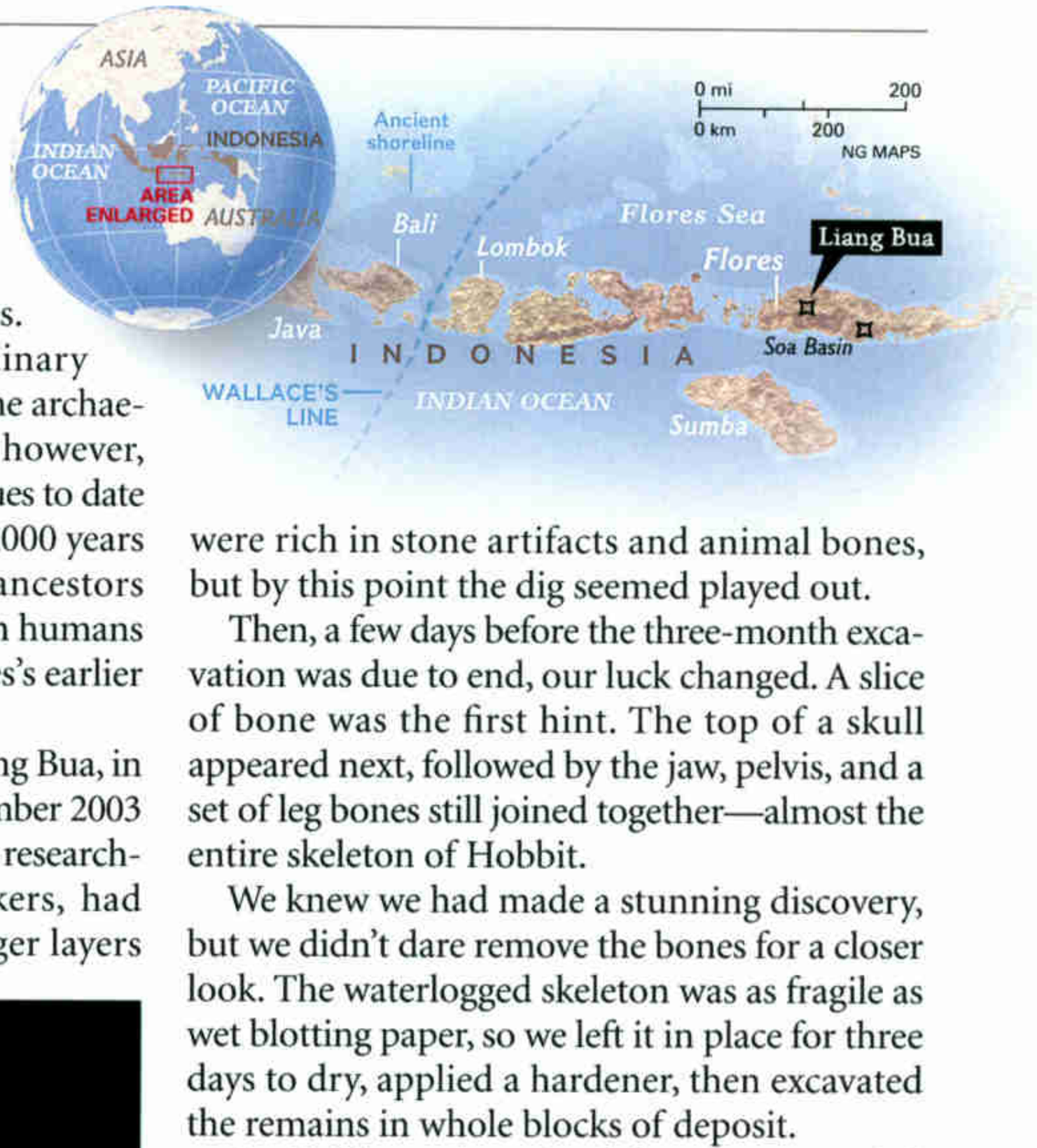
Then, a few days before the three-month excavation was due to end, our luck changed. A slice of bone was the first hint. The top of a skull appeared next, followed by the jaw, pelvis, and a set of leg bones still joined together—almost the entire skeleton of Hobbit.

We knew we had made a stunning discovery, but we didn't dare remove the bones for a closer look. The waterlogged skeleton was as fragile as wet blotting paper, so we left it in place for three days to dry, applied a hardener, then excavated the remains in whole blocks of deposit.

Cradled in our laps, the skeleton accompanied us on the flight back to Jakarta, Indonesia's capital. There Peter Brown, a paleoanthropologist from the University of New England in Australia, supervised cleaning, conservation, and analysis. The pelvic structure told him Hobbit was a female, and her tooth wear confirmed that she was an adult. Her sloping forehead, arched brow-ridges, and nutcracker jaw resembled those of *Homo erectus*, but her size was unique.

It wasn't just her small stature and estimated weight—about 55 pounds—but a startlingly small brain as well. Brown calculated its volume at less than a third of a modern human's. Hobbit had by far the smallest brain of any member of the genus *Homo*. It was small even for a chimpanzee.

The tiny skull is most reminiscent not of the hefty *Homo erectus* *(Continued on page 12)*



Thomas Sutikna of the Indonesian Centre for Archaeology holds a skull that he and fellow scientists believe represents a new human species, *Homo floresiensis*. Found in a cave on Flores (map), the species existed alongside modern humans as recently as 13,000 years ago, yet may descend from *Homo erectus*, which arose some two million years ago.

IRA BLOCK (LEFT AND SMALL SKULL, FAR LEFT)

FLORES FIND

Clues from an island cave

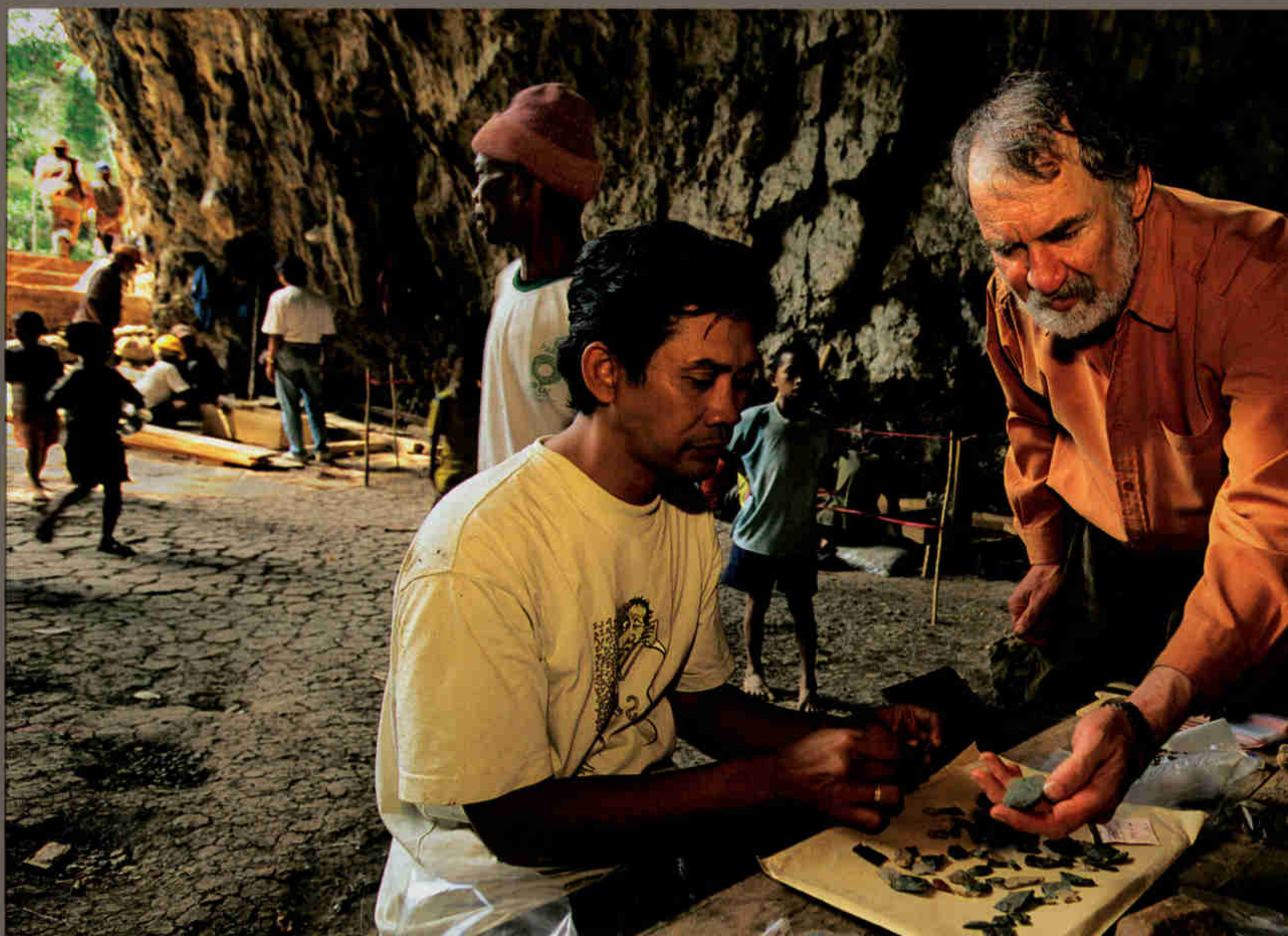
SCALE VARIES IN THIS PERSPECTIVE. DISTANCE FROM JAVA TO FLORES IS 376 MILES (604 KILOMETERS). IMAGE IS VERTICALLY EXAGGERATED.

SATELLITE IMAGE, WORLDSAT INTERNATIONAL INC.; IMAGE ENHANCED BY VLAD DUMITRASCU; NATIONAL GEOGRAPHIC MAPS

The first itinerant humans, *Homo erectus*, crossed land bridges from Asia to Indonesia. But their trail seemed to end at Java (above), the site of *Homo erectus* bones at least 1.5 million years old. No one believed these early humans could cross the ocean barrier called Wallace's line. Scientists thought it wasn't until 50,000 years ago that people —modern *Homo sapiens*— made the jump. But 840,000-year-old stone tools found in the Soa Basin on Flores are a sign that *Homo erectus* crossed Wallace's line much earlier. "How they managed to get there is still a real mystery," says Mike Morwood *of the University* of New England in Australia.

NO ANCIENT HUMANS COULD HAVE REACHED FLORES BEFORE BIG-BRAINED MODERN PEOPLE—OR SO IT SEEMED.

Looking for signs of early humans, archaeologists Wahyu Saptomo and Mike Morwood (below) examine stone artifacts found buried in a limestone cave that the local Manggarai people call Liang Bua. Above its massive entrance (above right) gray stalactites hang like jagged fangs, but the grim exterior belies an inner beauty. "It's very much like a cathedral inside," says Morwood, who has excavated here since 2001. He says islanders have used the cave as a burial ground for millennia. The dirt below its clay floor is riddled with human bones from a range of eras. But Morwood is interested in the cave's first occupants, *Homo floresiensis,* who arrived at least 95,000 years ago. The search has involved hauling tons of dirt bucket by bucket to a washing station set up in a nearby rice field (above left), where researchers sifted artifacts and bones from the mud. The work paid off with the discovery of remains from at least seven tiny individuals. The team also found well-flaked stone points—possibly spearheads—that suggest *Homo floresiensis,* although much smaller than its *Homo erectus* ancestors, was also smarter.



From left to right: *Homo sapiens, H. erectus, H. erectus* (Dmanisi), *H. floresiensis*

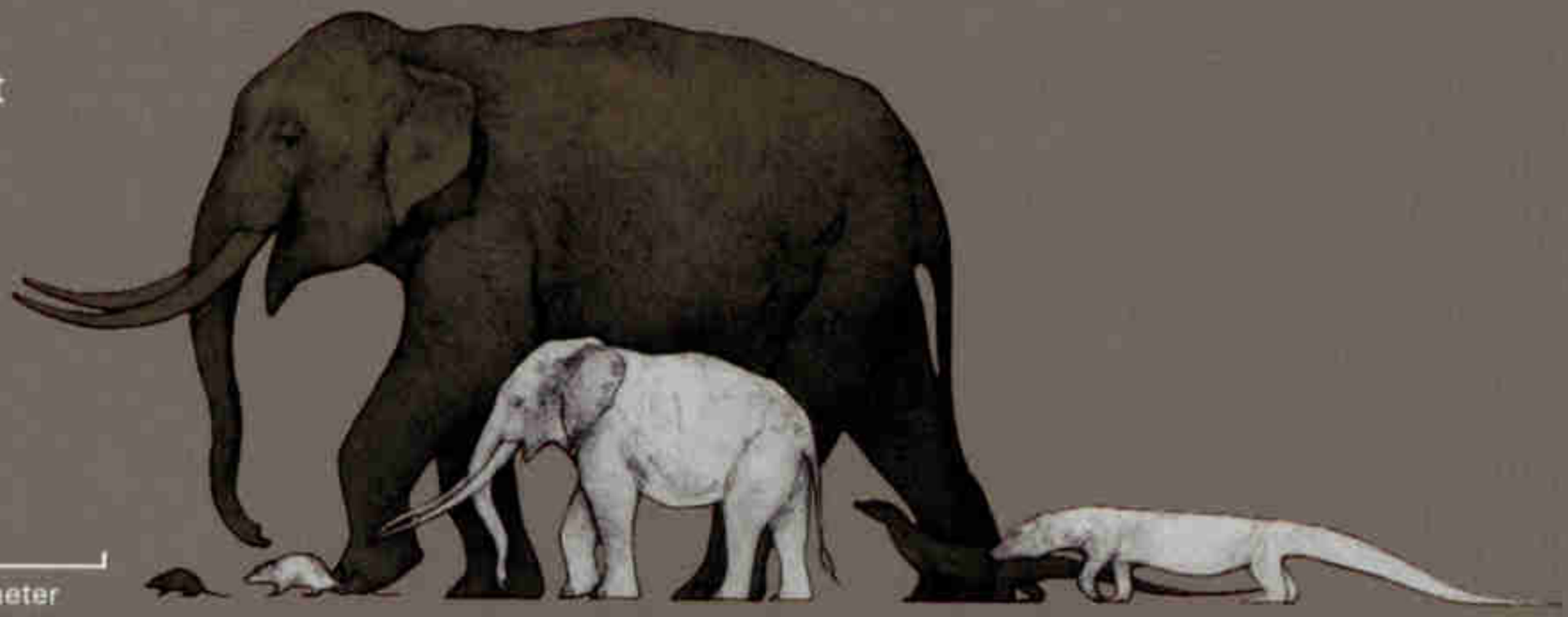
The *Homo floresiensis* skeleton stands roughly half as tall as a modern adult's. "I knew within about 60 seconds of seeing the jawbone that this was something entirely new," says paleoanthropologist Peter Brown, who examined the bones. The premolars are a giveaway, with a root much different from ours. The pelvis of this female is also wider than in *Homo sapiens.* Her arms hung almost to her knees, says Brown, but her delicate hand and wrist bones imply that "she wasn't doing a lot of climbing."

FLORES FIND

Where dwarfs met giants

FOR MILLENNIA THE ONLY LAND MAMMALS ON FLORES WERE RODENTS, STEGODONTS, AND HUMANS.

Why were the Flores humans so small? Biogeographer Mark Lomolino, who studies the phenomenon called island dwarfism, says, "We know that when evolutionary pressures change, some species respond by shrinking." Stegodonts—extinct elephant ancestors—were especially prone to dwarfing, because they often colonized islands. "Elephants are strong swimmers," he says. Once there, with limited food and fewer predators, they shrank. On Sicily, Crete, and Malta, scientists have unearthed bones from primitive elephants as little as a twentieth the size of mainland forms. But other species, such as rats, tend to grow larger in a place without competitors. Flores yielded remains of giant rats and lizards, as well as cow-size dwarf stegodonts and diminutive human bones (shown above with stone tools and stegodont teeth). Peter Brown says the tiny *Homo floresiensis* may have evolved from a population of *Homo erectus* that reached Flores some 800,000 years ago. "The problem is we haven't found *Homo erectus* bones," says Brown. "All we have is these small-bodied people."



FLORES WALKING SKELETON ART (LEFT) BY MARK SNOSWELL, SAM HODGE, AND DAMIAN SNELGROVE, SNOSWELL DESIGN & BALLISTIC MEDIA; ART (TOP LEFT AND RIGHT) BY GREG HARLIN; SOURCES (TOP LEFT): *H. SAPIENS*, CHRISTOPHER B. RUFF; *H. ERECTUS*, SUSAN C. ANTÓN AND CONNIE FELLMAN

(Continued from page 7) from elsewhere in East Asia but of older, smaller *erectus* fossils. Viewed from above, the skull is pinched in at the temples, a feature also seen in the 1.77-million-year-old Dmanisi people from Georgia, in western Asia. And in some respects, such as the shape of her lower jaw, the Liang Bua hominin harks back to even earlier fossils such as Lucy, the 3.2-million-year-old *Australopithecus* from Ethiopia.

And yet—strangest of all—she lived practically yesterday. Radiocarbon dating of charcoal pieces found next to the skeleton, together with luminescence dating that indicated when the surrounding sediments were last exposed to the sun, revealed her 18,000-year age. By mid-2004 our excavation at Liang Bua had yielded bones and teeth from at least six other individuals, from about 95,000 until as recently as 13,000 years ago.

For a few skeptics, all this is too much to swallow. They argue that the one complete skull must have come from a modern human with a rare condition called microcephaly, in which the brain is shrunken and the body dwarfed. The other small bones, they say, might be the remains of children. But last year's discoveries include part of a second adult skull—a lower jaw—that is just as small as the first. It simply strains credibility to invoke a rare disease a second time.

Instead, Hobbit is our first glimpse of an entirely new human species: *Homo floresiensis*. Her kind probably evolved from an earlier *Homo erectus* population, likely the makers of the tools Verhoeven found. Her ancestors may have stood several feet taller at first. But over hundreds of thousands of years of isolation on Flores, they dwindled in size.

Such dwarfing is often the fate of large mammals marooned on islands. There they generally face fewer predators—on Flores, Komodo dragons were the only threat—which makes size and strength less important. And the scarce food resources on a small island turn a large, calorie-hungry body into a liability. On mainland Asia, stegodonts sometimes grew bigger than African elephants; at Liang Bua they were only a bit bigger than present-day water buffalo.

In the past some anthropologists have argued that even in prehistory humans could adapt to new environments by inventing new tools or behaviors rather than by physically evolving, like other creatures. The dwarfing seen on Flores is powerful evidence that humans aren't exempt from natural selection. The discovery of Hobbit is also a hint that still other human variants may once have inhabited remote corners of the world.

In spite of their downsized brains, the little people apparently had sophisticated technology. The fireplaces, charred bones, and thousands of stone tools we found among their remains must have been their handiwork, for we found no sign of modern humans. Stone points, probably once hafted onto spears, turned up among stegodont bones, some of which bore cut marks. The little hominins were apparently hunting the biggest animals around. It was surely a group activity—adult stegodonts, although dwarfed, still weighed more than 800 pounds, formidable prey for hunters the size of preschool children.

The discovery underscores a puzzle going back to Theodor Verhoeven: How could ancient hominins ever have reached Flores? Was *Homo erectus* a better mariner than anyone suspected, able to build rafts and plan voyages? And it raises a new and haunting question. Modern humans colonized Australia from mainland Asia about 50,000 years ago, populating Indonesia on their way. Did they and the hobbits ever meet?

There's no sign of modern humans at Liang Bua before 11,000 years ago, following a large volcanic eruption that would have wiped out any *Homo floresiensis* in the region. But other bands may have hung on elsewhere in Flores. Perhaps modern humans did meet their ancient neighbors before something—maybe a changing environment, maybe competition or conflict with modern humans themselves—spelled the end for the little people. Further excavations on Flores, and on nearby islands that might have had their own hobbits, may settle the question.

In the meantime a clue may come from local folktales about half-size, hairy people with flat foreheads—stories the islanders tell even today. It's breathtaking to think that modern humans may still have a folk memory of sharing the planet with another species of human, like us but unfathomably different.

The Australian Research Council supported this work; your Society will help sponsor future study. □

HOBBIT: A WHOLE NEW KIND OF HUMAN Share your thoughts in our forum and see how artists and scientists created a three-dimensional model of the Flores hominin—from bone to flesh—at **nationalgeographic.com/magazine/0504**.

PERHAPS MODERN HUMANS DID MEET THEIR ANCIENT NEIGHBORS BEFORE SOMETHING SPELLED THE END FOR THE LITTLE PEOPLE.

An imagined encounter between a modern human and a tiny Flores human. No definitive evidence has emerged that the two species met, but scientists think they coexisted for some 40,000 years.

FLORES AND DMANISI FINDS

Two species separated by 1.8 million years and 6,000 miles. Are they distant cousins?

In analyzing the bones of a tiny human relative called Hobbit, from the Indonesian island of Flores, scientist Peter Brown noted that they looked more like *Homo erectus* remains recently found at Dmanisi in western Asia than like *Homo erectus* from nearby Indonesian islands. "That's very weird," he says. Much research must be done to determine if the two species are linked.

For now, the finds are adding to the picture of early human diasporas. Dmanisi shows that human ancestors left Africa earlier than was thought and that these wanderers had adopted a carnivore's protein-laden diet. Meat-eating may have been key to survival outside Africa, and it may have set human ancestors on an evolutionary course to larger brains, typical of predators. Meanwhile, Flores suggests hominins crossed stretches of ocean much earlier than scientists believed, leading scholars to wonder about other unknown human species. "*Homo erectus* may have reached many Indonesian islands and evolved," says Richard Roberts of Australia's University of Wollongong. "We may be in for more surprises."

▶ Visit a gallery of 3-D skulls from early humans to explore how the Flores hominin, the "old man" from Dmanisi, Lucy, and other well-known specimens differ at **nationalgeographic.com/magazine/0504.**

Asian Odyssey

Dmanisi
Homo erectus
Specimen D3444
1.77 million years old

2 million years ago — 1.5 m.y.a.

ASIA

CHINA

Homo erectus dispersal from Africa

Nihewan
Earliest stone tools in East Asia, 1.7 m.y.a.

Zhoukoudian
Collection of fossils known as Peking man
670,000-410,000 years ago

Hominin site
- *Homo erectus*
- *Homo sapiens*
- Other

SOURCES:
SUSAN C. ANTÓN, NEW YORK UNIV.; RUSSELL L. CIOCHON, UNIV. OF IOWA; JOHN G. FLEAGLE, STONY BROOK UNIV.; MICHAEL MORWOOD, UNIV. OF NEW ENGLAND

ART BY GREG HARLIN
NATIONAL GEOGRAPHIC MAPS

PACIFIC OCEAN

INDIAN OCEAN

Niah Cave
40,000 years ago

WALLACE'S LINE

INDONESIA

Mojokerto
1.8 m.y.a.

Jakarta

Bali

Sangiran
1.6-1.0 m.y.a.

Java

Trinil
Java man
900,000 years ago

Ngandong
53,000-27,000 years ago

Liang Bua
95,000-13,000 years ago
(Hobbit: 18,000 years ago)

Soa Basin
Artifacts
840,000-650,000 years ago

Lombok

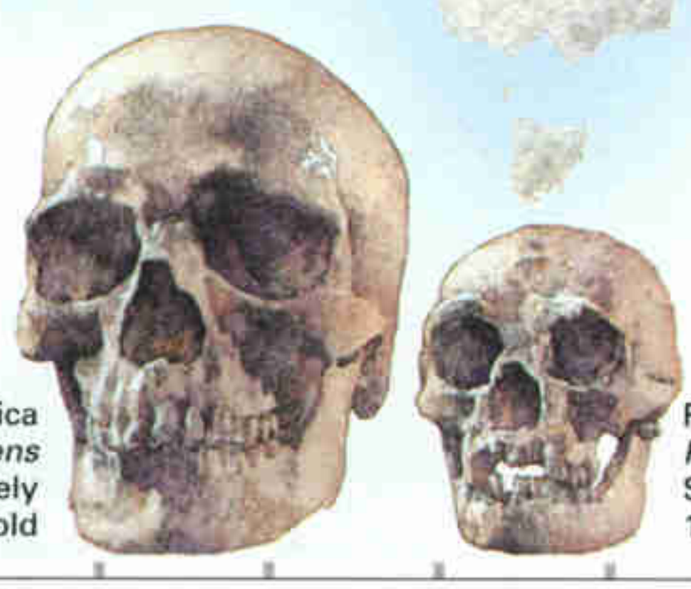
Flores

Malakunanja II
50,000 years ago

AUSTRALIA

SMALL SKULLS, BIG MILESTONES ON THE HUMAN EVOLUTIONARY HIGHWAY.

Skulls from Dmanisi and Flores mark new entries in the fossil record. Both are much smaller than a *Homo sapiens* skull. While Dmanisi signals an early step in our evolution, the tiny Flores skull shows the power of an isolated environment to shape the human form.



Africa
Homo sapiens
Approximately 200,000 years old

Flores
Homo floresiensis
Specimen LB1
18,000 years old

1 m.y.a. — 500,000 — Present

Family

DMANISI FIND

These prehistoric pioneers adopted a new
and gave rise to later humans—

Ties

Working in clay, an artist added skin, muscle, and eyes to casts of skulls from Dmanisi, in the republic of Georgia. Discoveries there are fleshing out a new portrait of early humans.

way of life based on cooperation, even caring,
from the Flores people to ourselves.

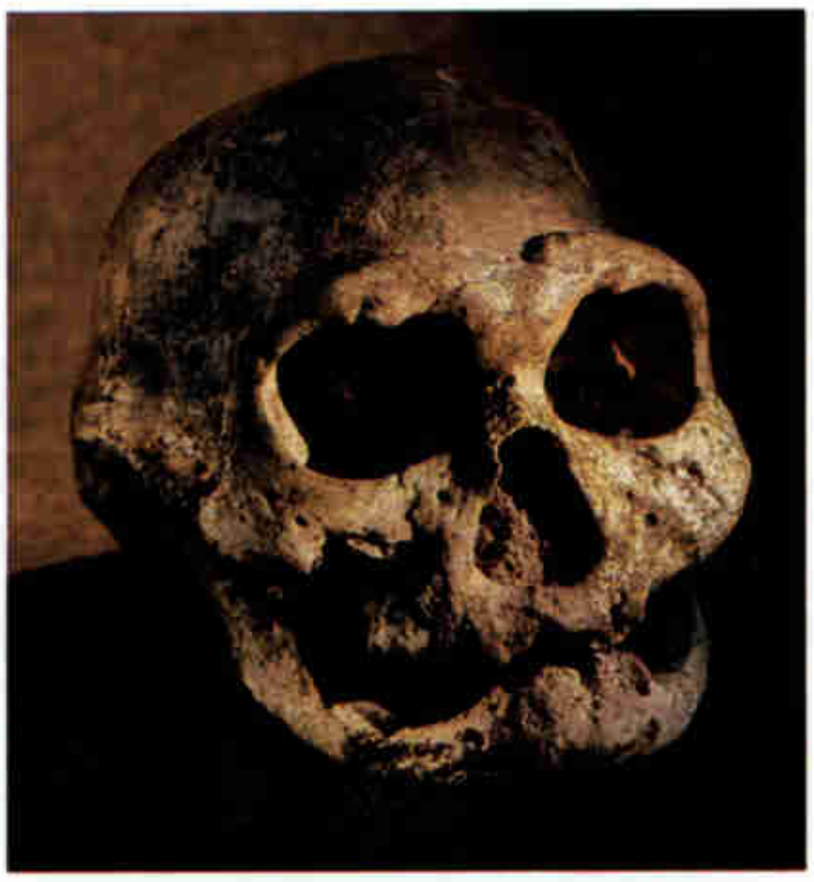
PHOTO ILLUSTRATION BY JOHN GURCHE

BY JOSH FISCHMAN
PHOTOGRAPHS BY KENNETH GARRETT
ART BY JOHN GURCHE

Across a dusty courtyard at the

Georgian State Museum, up three flights of stone steps, and down a long hallway, humanity's distant past lies waiting. On a table in a high-ceilinged room rests a replica of a skull, empty eye sockets peering over the plaster wrapping around the lower face. "But let me show you the real thing," says David Lordkipanidze, a paleoanthropologist and the director of the museum in Tbilisi, capital of this former Soviet republic.

Lordkipanidze slowly lifts the lids of four wooden boxes, one by one. Inside are bare skulls, nearly 1.8 million years old. "Here, this is our teenager," he says. The skull does look youthful, with small, even graceful features, some of the teeth not yet fully grown in. "And this is what we're calling the old man," he continues. Again, the skull is humanlike but small. But the remarkable feature is the mouth.



Not only are there no teeth, but nearly all the sockets are smooth, filled in by bone that grew over the spaces. The jaws look like two crescent moons. Although it's hard to be sure of his age, "it looks like he was maybe about 40, and the bone regrowth shows he lived for a couple of years after his teeth fell out," says the anthropologist. "This is really incredible." How did the toothless old man survive, unable to chew his food? Maybe his companions helped him, says Lordkipanidze. If so, those toothless jaws might testify to something like compassion, stunningly early in human evolution. You have to flash forward more than one and a half million years, to the Neandertals of Ice Age Europe, to see anything comparable.

He smiles and spreads his arms to encompass the old man, the teenager, and two more skulls. "We hit the jackpot."

Lordkipanidze and his colleagues hit it in a very unexpected place: not in Africa, home to famous fossils like Lucy and famous sites like Tanzania's Olduvai Gorge, but well to the north, in Georgia, where Europe ends and Asia begins. Found in the shadow of a ruined medieval castle near the small town of Dmanisi, the four skulls and other bones provide a rare snapshot of what could be a single population of hominins, as anthropologists now call humans and their ancestors. Most hominin fossils are isolated individuals, but having a collection of them lets researchers study the range of age and body size within a single group.

It's a group that had a key role in human evolutionary history. The human ancestors found at Dmanisi—early members of a species called *Homo erectus*—appear to be the first hominins to have left Africa, where our evolution began. They were short and small-brained, seemingly ill-suited to travel. Yet they evidently had advantages that outweighed their physical shortcomings: a new way of life based on hunting or

A toothless *Homo erectus* skull (above) discovered at Dmanisi poses an intriguing question: How did he survive without chewing? Maybe he found soft foods, or perhaps another hominin helped him (right)—which, if true, would be the first sign of human caring.

scavenging and, Lordkipanidze and his colleagues think, a new kind of social cooperation.

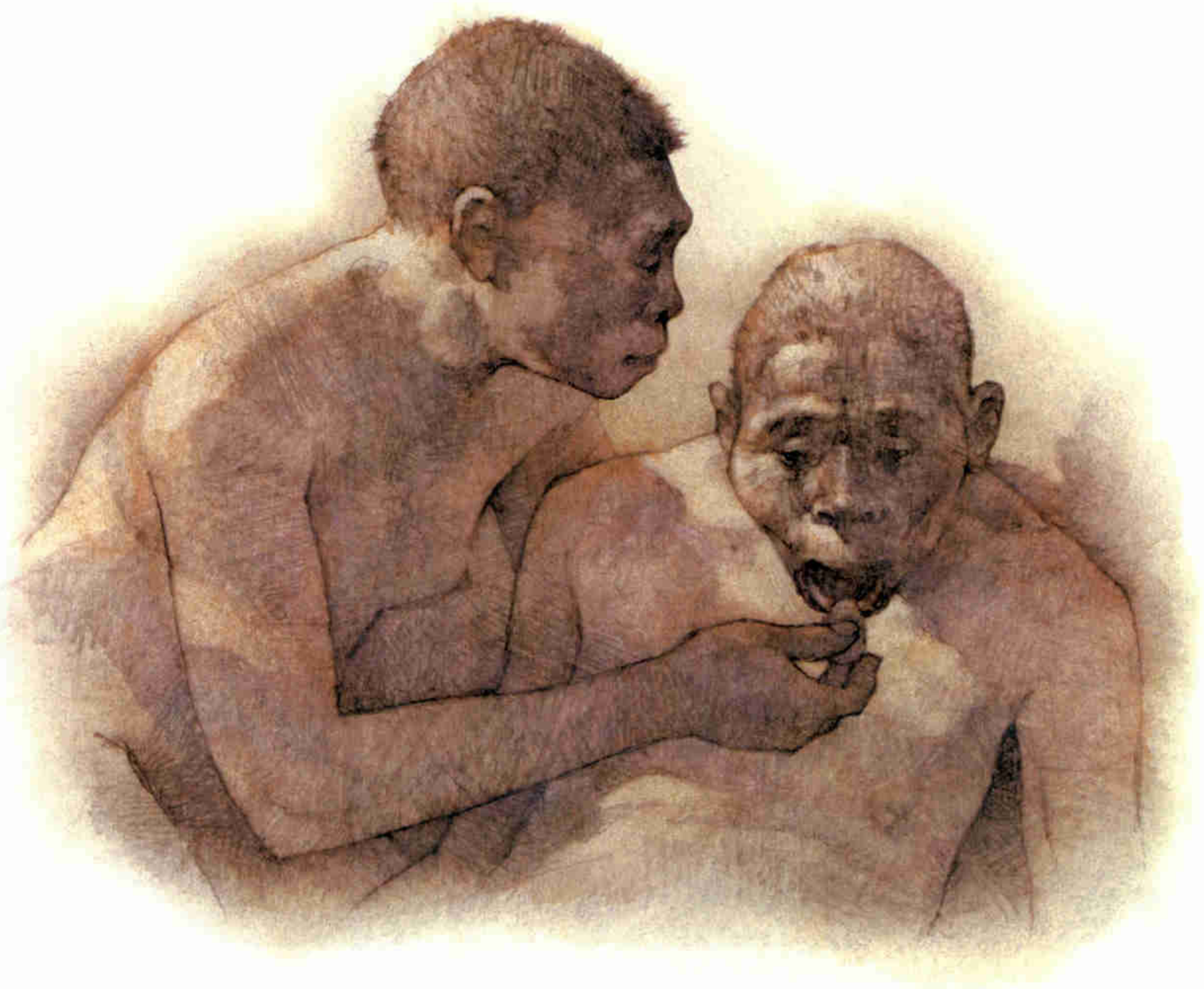
In the survival of the old man, "we're looking at perhaps the first sign of truly human behavior in one of our ancestors," says Lordkipanidze. It could be a glimpse of a new level of planning and sharing, adds Philip Rightmire, an anthropologist at Binghamton University in New York State who is on the Dmanisi research team. "Seeing this at the very dawn of *Homo*, our own genus," he says, "may be the most exciting thing of all."

The ancient site lies on a wooded plateau a short walk from Dmanisi. Two rivers flow through deep gorges on either side of the plateau before meeting at its tip, where the land rises like a prow over fields and pastures.

Almost two million years ago, before the hominins moved in, a series of volcanic eruptions flooded the site with lava, which hardened into basalt. Later, more eruptions dumped tons of ash on top of the rock. In between those catastrophic rains of ash, life crept back onto the plateau, including hominins who lived and died there. Buried by later ashfalls, their bones lay entombed until the 1990s, when archaeologists excavating the medieval ruins began finding very old bones beneath the crumbled cellars.

The layers of basalt and ash are key to dating the fossil deposit. Rocks contain tiny grains of magnetic material that record the direction of the Earth's magnetic field at the time they hardened. At Dmanisi, the magnetic grains give anthropologists a clear time benchmark. While the grains in the basalt and the oldest ash layers point north, those in the ash on top point south because the Earth's magnetism reversed after the lava flow but before the last ashfall. That magnetic flip took place 1.78 million years ago.

The lava flow and ashfalls must have taken place in quick succession, says Dmanisi researcher



ART BY GREG HARLIN

DMANISI FIND

Hunting ground or home base?

EARLY HUMANS LIVED ON THE PLATEAU DURING LULLS IN VOLCANIC ERUPTIONS.

Bones and crude stone tools from Dmanisi allude to a brutal chapter in early humans' campaign to move up the food chain. "This was likely a hunting ground for lots of predators," says paleoanthropologist Martha Tappen, noting that the site (below) had water on three sides, creating a cul-de-sac that would help trap prey. Tappen has spent four summers studying fossil bones from the site, including a bone fragment (left, at top), probably from a deer. The stone tool shown with the bone was found nearby.

Telltale marks on the bones show that the Dmanisi people used stones to butcher animals, says Tappen. They also provide the earliest evidence of carnivorous hominins in Eurasia and support a theory that eating meat allowed early humans to survive in northern latitudes, where plant foods might be scarce in winter. Whether the site was a seasonal camp or a permanent base is unclear. With saber-toothed cats lurking, says Tappen, "it might not have been safe for the humans to sleep there."

Reid Ferring, a geologist and archaeologist from the University of North Texas. "The rock underneath isn't weathered," he notes, "so it was covered up before the rain and wind could get to it." Human ancestors occupied the site after the magnetic flip, during a short lull in the eruptions—"10,000 years at most," Ferring says, "and maybe as little as a few hundred."

True, it's enough time for the four individuals unearthed there to have lived generations apart. But they occupied the same small patch of ground. "Look at this," says Ferring, standing in a pit about 20 feet deep at the excavation. It's called the Champagne Room because this is where the overjoyed excavators unearthed the skulls. "We found one jaw over here"—Ferring plants his boot on a patch of dark dirt—"and one skull just over here"—he points with his other foot to a spot just a few feet away. "If you lie down right, you could play a game of Twister on these bones. That's how close they were." Ferring pauses. "You know, it's even possible that some of these folks knew one another."

Even if they didn't actually set eyes on one another, a handful of individuals living at the same site in a relatively short time span can be thought of as a population, a group that closely shared genes and lifestyles. At places like Olduvai, individual fossils are so far apart in time—hundreds of thousands of years or more—that scientists argue over whether differences among them indicate different species or just the kind of variations you might see among people today.

At Dmanisi, for the first time, anthropologists are getting a good look at a population, young and old. They're starting to appreciate just how much variety can crop up within a single group. And the range of features they're seeing is helping them fit Dmanisi into humanity's evolutionary odyssey.

Many of those features resemble those of *Homo erectus,* the first well-traveled hominin, found both in Africa and far across Asia. Straight browridges, a line of heavy bone running front-to-back across the top of the skull, and the shape of the nasal cavity all link the Dmanisi skulls to classic *erectus* fossils from hundreds of thousands of years later and thousands of miles away known as Java and Peking man, from Indonesia and China, as well as fossils from Kenya.

But some telling differences suggest that Dmanisi was more than a way station for *Homo erectus.* The Dmanisi skulls are small for *erectus* and rounded instead *(Continued on page 26)*

David Lordkipanidze (fourth from left) and fellow scientists carry a crate holding a 1.77-million-year-old human cranium—the toothless "old man"—dug up in 2002 near Dmanisi, in the Caucasus Mountains. The site has yielded a rich array of *Homo erectus* bones.

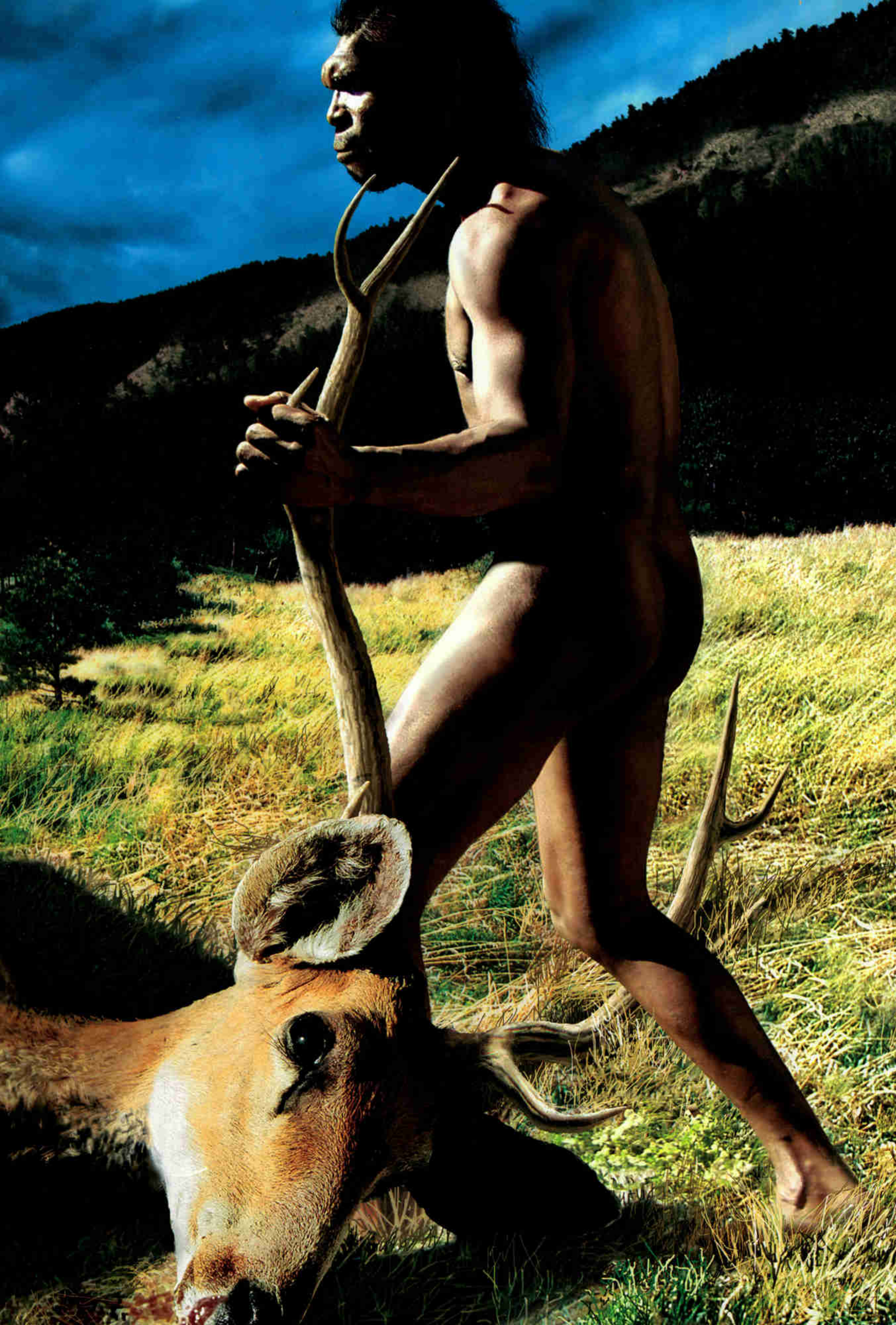
From left to right: *Homo sapiens, H. erectus, H. erectus* (Dmanisi), *H. floresiensis*

SEEING A RANGE OF BONES IS HELPING SCIENTISTS FIT DMANISI INTO OUR EVOLUTIONARY JOURNEY.

Bones from at least two of the four individuals found at Dmanisi form a rough outline of an early *Homo erectus* skeleton. Scientists continue to analyze the more than 50 human bones found at the site, which holds the largest cluster of *Homo erectus* remains ever found in one place. Small details can offer important insights. The thick foot bones suggest a robust adult who hiked nearby hills, and the leg bones indicate that one individual stood four feet seven inches tall—a bit shorter than other *Homo erectus* specimens but much taller than *Homo floresiensis.*

ART BY GREG HARLIN. SOURCES: *H. SAPIENS,* CHRISTOPHER B. RUFF; *H. ERECTUS,* SUSAN C. ANTÓN AND CONNIE FELLMAN

The scene of a fresh kill could have become chaotic as carnivores—both human and animal—competed for meat. The array of bones uncovered at Dmanisi includes saber-toothed cats and extinct deer, ostriches, giraffes, horses, wolves, and hyenas, revealing an area rich in both prey and predators. Scientists aren't sure how the early humans got their meat. "The hominins probably did more scavenging than hunting," says paleoanthropologist Philip Rightmire. "They had only crude stone tools, so it is likely they chased away predators from carcasses." At this point, he notes, "humans were as likely to be the hunted as the hunters."



(Continued from page 21)

of angled at the back, traits reminiscent of an earlier species, *Homo habilis*, or "handy man," which appeared in Africa before two million years ago. "My feeling is that we can say this is something between *habilis* and *erectus*, and maybe it's the founder of *erectus*," says Lordkipanidze.

That would make Dmanisi the true starting point for the journeys of *Homo erectus*. Here is how events might have unfolded: Dmanisi-like hominins evolved from *Homo habilis* in Africa by about two million years ago. Almost immediately they wandered out of Africa and through the Middle East to Georgia, completing the transition from *habilis* into *erectus*. Then they branched out. Some, the forerunners of Peking man and Java man, went on to East Asia and Indonesia. Others doubled back to Africa, where lanky and somewhat more slender African versions of *erectus*—which are also known as *Homo ergaster*—emerged later. In the end these *erectus* variants gave rise to modern humans, who ultimately set out on global journeys of their own.

In that picture, human ancestors first took to the highway hundreds of thousands of years earlier than anthropologists used to think—and well before they seemed ready to make the journey. Forms of *Homo erectus* that appeared in Africa by 1.8 to 1.5 million years ago were once believed to be the first wanderers in our family tree, leaving Africa as recently as a million years ago. These hominins looked like capable travelers. They had long legs, good for covering a lot of ground, with some skeletons about six feet in height. They were technological innovators, developing the first hand axes and other sharp-edged stone tools by 1.5 million years ago. And they had a brain size averaging about 900 cubic centimeters, much bigger than anything previous and approaching today's average of 1,350 cubic centimeters.

Compare that with the runty group at Dmanisi, where one individual barely topped four-and-a-half feet. They had an average brain size of 650 cubic centimeters, much closer to creatures limited to Africa, like *Homo habilis*. And tools? Nothing special—just stone flakes dislodged by knocking rocks together, as human ancestors had been doing for hundreds of thousands of years before Dmanisi. How, one can be forgiven for asking, did they ever get out of Africa?

"I think they may have followed a trail of carcasses," says paleontologist Lorenzo Rook, a team member from the University of Florence in Italy. At the time predators like saber-toothed cats were invading new territory, such as Asia. Big carnivores tend to bring smaller meat-eating creatures with them, hangers-on that are drawn to the leftovers of a kill. Among them might have been hominins that had adopted a new feeding strategy: eating meat.

"When you come to meat-eating as a reason for getting out of Africa, it works pretty well," says Martha Tappen of the University of Minnesota, who studies the animal bones at Dmanisi. "Why couldn't Lucy and creatures like that make it out of Africa? They were largely vegetarian. Up in Georgia it's seasonal. You can't get

The four Dmanisi skulls may be just the tip of an archaeological iceberg. "At the rate we are going," says scientist Reid Ferring, "dozens of early humans could be found at Dmanisi."

fruit year-round. So you have to switch to meat with veggies." Dmanisi, she adds, was a natural steak house. "It's a great animal trap—this tip of land surrounded by water. So Bambi wanders out, and sabertooth is there waiting. There's nowhere to run." Hominins could have joined the hungry scrum.

SOCIETY GRANT

This Research Committee project is supported by your Society membership.

The animal bones from the site include extinct forms of big cats and bears, small wolves, ostriches and other birds, horses, deer, and giraffes. Hominins clearly dined on some of the gentler creatures, says Tappen. "I've found a handful of cut marks on animal bones, made with stone tools." They are "clear signs of butchery," she says, and could indicate that the Dmanisi hominins were killing animals and stripping meat from their bones rather than just scavenging what other carnivores left behind.

Bigger predators may have dined on the hominins themselves: Chew marks appear on at least one of their bones. "Maybe they were trapping, and also getting trapped," Tappen says. Human ancestors "were not at the top of the food chain yet." That's why scientists aren't sure what to make of the caches of river stones that turned up near the hominin bones. Maybe the Dmanisi people hurled the stones at small game. But given their perilous existence, they might have been hoarding stones for defense against lurking predators—or for driving the predators away from carcasses so that they could scavenge the remains.

It's tempting to imagine human ancestors living furtive, fearful lives at Dmanisi, competing with creatures that could kill them with a swipe of a claw. Yet this risky shift to eating meat also may have put our ancestors on the road to becoming the planet's dominant species. "Predation is a big evolutionary force," Tappen says. "It drives a lot of changes in anatomy and behavior. One thing we know is that predators get smarter than herbivores." It takes more planning to hunt or scavenge than to pluck fruit. "So [meat-eating] might be leading to larger brain sizes."

And more brainpower might have led to sophisticated group behavior, which could explain the survival of the "old man." After losing his teeth, he might have fended for himself for a while, using stones to mash up softer plants as well as scraps of meat. "But remember this place has seasons, so plants aren't always there," says Ferring. The slow-moving elder probably could not support himself through the winter by hunting or scavenging. To survive, Ferring thinks, he probably had to rely on his companions to bring him small pieces of meat.

There are hints that a crippled *Homo erectus* might have received similar help in Africa about 1.7 million years ago. But there's no other sign of prehistoric compassion as clear-cut as the Dmanisi oldster's smooth jaws until the Old Man of La Chapelle-aux-Saints, a Neandertal skeleton from 60,000 years ago with many missing teeth and crippling arthritis, who definitely needed help to survive.

Lordkipanidze admits that his interpretation of the Dmanisi discoveries is far from certain. "What we are doing is like reconstructing a crime scene," says Lordkipanidze, who as a boy loved mystery novels—Agatha Christie and Arthur Conan Doyle. "The crime was long ago, and you can't find witnesses."

That leaves only the clues from the ground, and some anthropologists believe they tell a different tale. These skeptics think the old man could have found enough to eat on his own, and they aren't convinced that the Dmanisi fossils represent the very beginning of the *Homo erectus* line rather than an offshoot. A few even question whether the fossils belong to a single group at all. The doubts focus on a massive jaw from the site, much bigger than the other fossils. It could simply have come from the biggest guy in town. Or it could be a sign that Dmanisi was home to two hominin species.

But if the clues add up the way Lordkipanidze thinks, Dmanisi offers a glimpse of humanity's deepest roots. Marc Meyer, a graduate student from the University of Pennsylvania who has worked at Dmanisi over several years, remembers the awe he felt as he dug for clues to our beginnings. "When you see the yellow of a bone, you first think, I've got to slow down. It's just this yellow flash, and you think, This could be my ancestor." □

SEE EXCLUSIVE 3-D MODELS of the Dmanisi "old man" and other *Homo erectus* specimens found there, look for individual differences among them, and share your thoughts in our forum at **nationalgeographic.com/magazine/0504**.


GALACTIC
N318SL
SCALED
N328KF

By Burt Rutan

Photographs by Jim Sugar

rocket for the rest of us

The creator of SpaceShipOne says private space flight's about to take off.

At the dawn of a new era, *SpaceShipOne* is minutes away from being released by its launch aircraft, *White Knight*, on September 29, 2004. With pilot Mike Melvill at the controls, the pioneering civilian rocket would climb to more than 62 miles (100 kilometers) in the first of two flights to win a ten-million-dollar prize.

29 MARK GREENBERG, WORLD PICTURE NEWS

Burt Rutan shows off his hot rod spaceship at his workshop in Mojave, California, where pilot Brian Binnie (below) weighs in before the October 4 flight. Binnie and Melvill wore the same lucky charm (below left) on their flight suits.

To me this would be the fulfillment of a childhood dream.

Just before sunrise on October 4, as the launch vehicle *White Knight*—with *SpaceShipOne* tucked neatly under its belly—was poised to taxi onto the runway at Mojave Airport in California, I stuck my head inside the tiny graphite-and-epoxy rocket to give pilot Brian Binnie a few last words of advice. I knew that Brian, an avid golfer like me, would get my meaning. "Use a driver," I said. "Keep your head down and swing smooth."

My message: Shoot for the greatest possible performance, but also strive for accuracy. Brian's job wasn't going to be easy. To qualify *SpaceShipOne* for the ten-million-dollar Ansari X Prize, he had to fly himself and the equivalent of two passengers—a total of 595 pounds—to an altitude of at least 100 kilometers (328,000 feet) and return for a safe landing. We'd measured his payload precisely. But nobody had planned on Brian's mother-in-law contributing a last-minute surprise. As Brian got ready to enter the cockpit, she gave him a big hug, spilling a cup of coffee all over his flight suit.

"I got soaked," Brian said. "I later figured those extra 12 ounces probably cost me 200 feet of apogee."

We were used to surprises by then. Five days before, test pilot Mike Melvill had taken

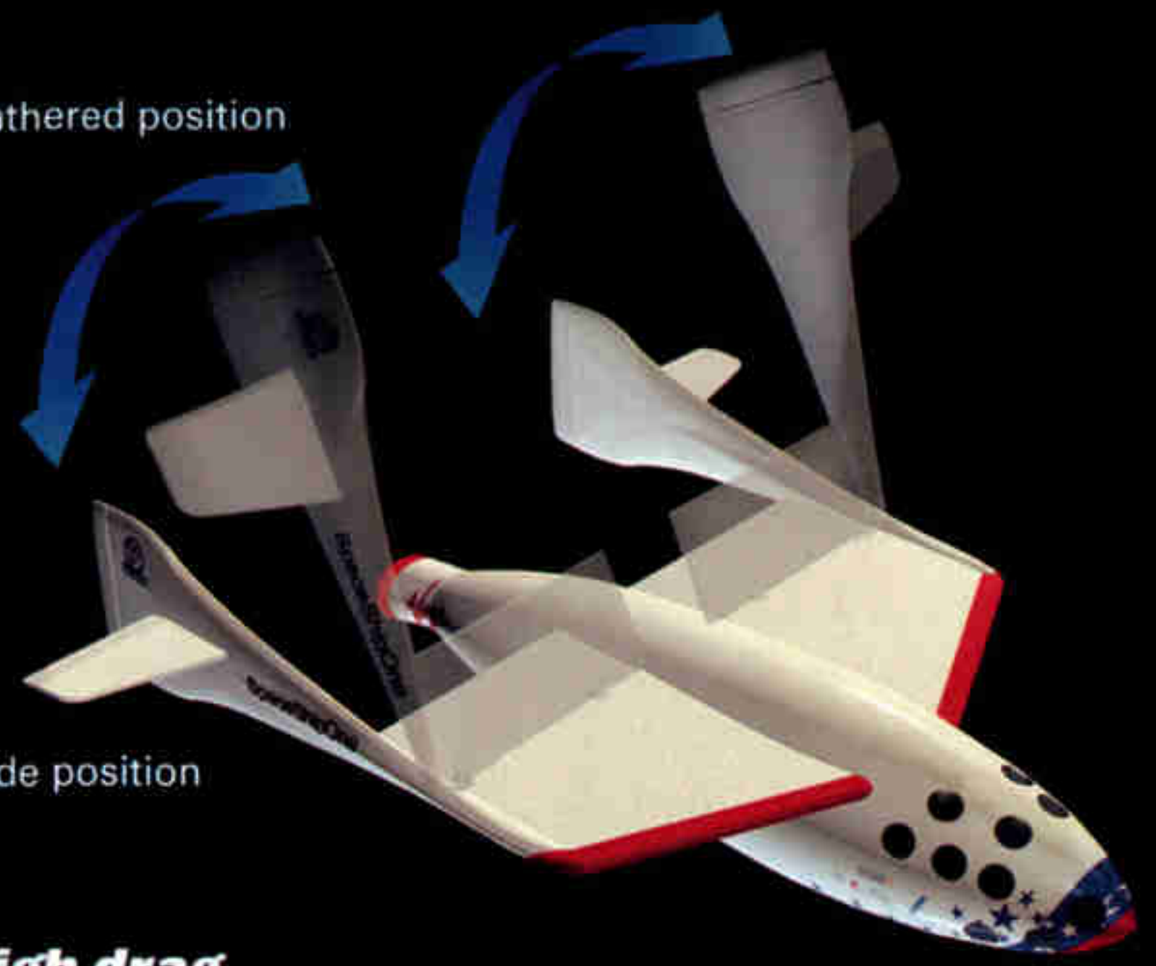
SpaceShipOne to more than 337,500 feet—the first of the two suborbital spaceflights required within two weeks to win the X Prize. But as Mike had rocketed toward the edge of space, *SpaceShipOne* had started spinning at an alarming rate. Mike was never in any danger, but the unexpected rolls left us scratching our heads.

For the next two days none of us got much sleep. We eventually hypothesized that the rolls were caused by a lack of directional stability as the rocket left the atmosphere. Mike may also have been pushing a little too hard on the rudder pedal. The incident led me to ask if I might be pushing too hard as well. I gathered the team together 48 hours after Mike's flight to see if they were ready to try again. Their response: a wholehearted yes.

As the designer of both *SpaceShipOne* and *White Knight,* I had a lot riding on our team's success. Not only did I hope to bring home the X Prize, I also wanted us to prove that privately built spaceships could achieve what the U.S. government has not: develop technology to make spaceflight affordable and safe for the masses.

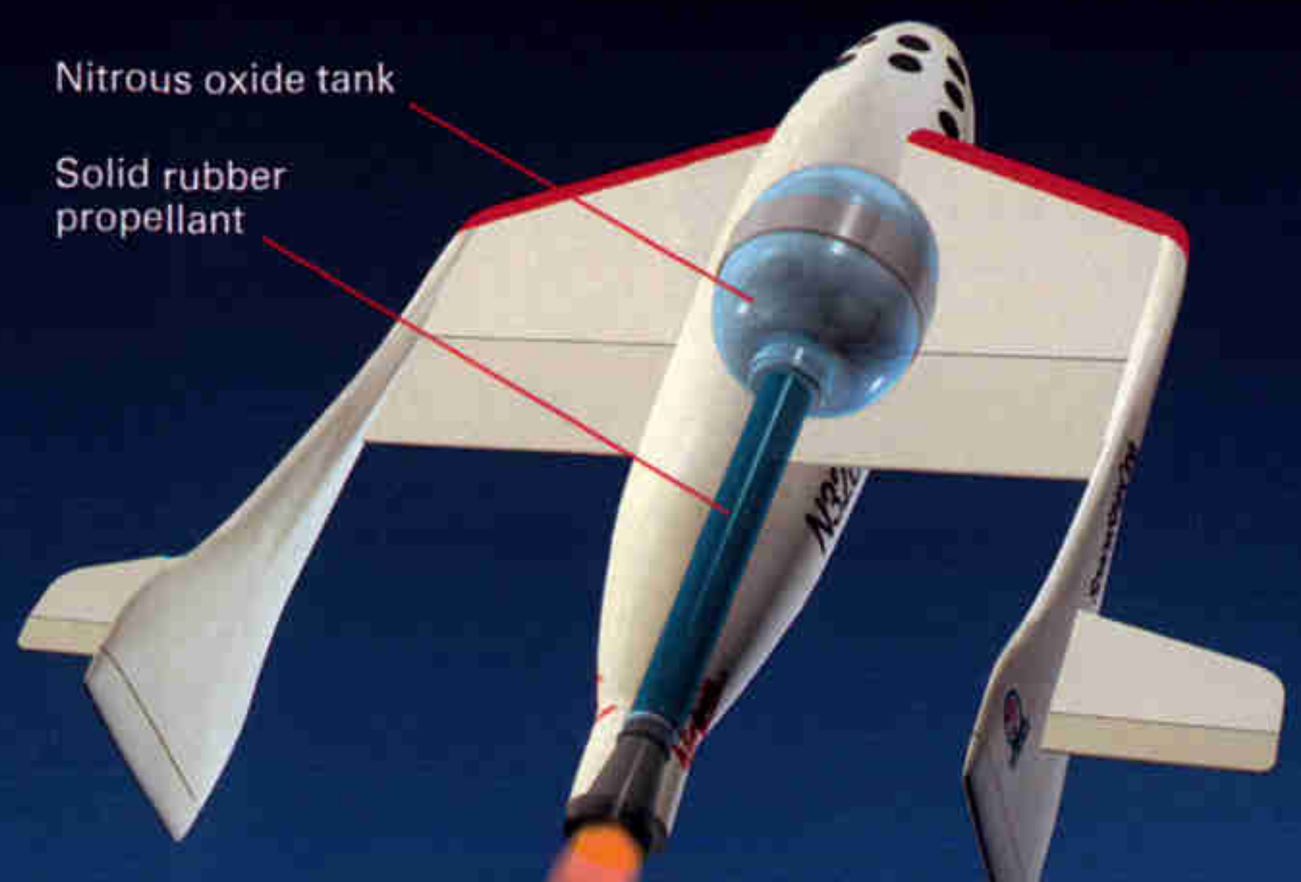
To me this would be the fulfillment of a childhood dream. I was 14 years old when Sputnik was launched into orbit, and I convinced myself, naively, that the space race would one day punch my personal ticket to the stars. Someday, I told myself, I too would be able to hop aboard

How to build a better spaceship



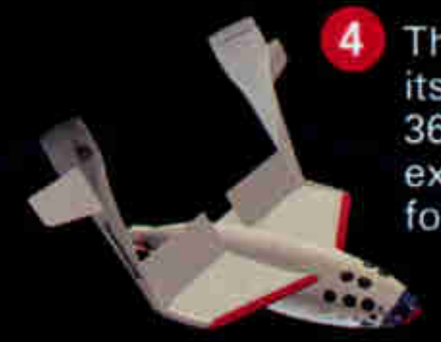
High drag

By rotating both tails and a third of the wing 65 degrees into a "feathered" position—like a badminton shuttlecock—the spacecraft increases drag, which slows its descent, prevents overheating, and increases stability for a "carefree" reentry.



2 The motor burns for some 90 seconds; the spacecraft climbs steeply as it accelerates to three times the speed of sound.

3 At an altitude of 213,000 feet, the pilot shuts off the rocket motor and swings the tail booms into the "feathered" position.



4 The craft coasts to apogee—its highest point—at around 367,500 feet, and the pilot experiences weightlessness for about three minutes.

328,000 feet: the edge of space

5 Tail booms, still in the feathered position, provide stability as the spacecraft reenters the atmosphere belly first. The pilot is pressed into his seat with a force 5.4 times that of his own weight.

Cheap thrust

Combining the best features of liquid fuel (nitrous oxide) and solid fuel (synthetic rubber), Rutan's company, Scaled Composites, created a safe, inexpensive rocket engine that can be turned off when necessary and changed out in less than a day.

Hitching a ride

Just as the X-15 rocket plane was carried aloft by a modified B-52 in the 1960s, *SpaceShipOne* gets a lift from *White Knight,* reducing both the risks of a runway takeoff and the amount of fuel required to reach space.

1 **October 4, 2004**
7:49 AM PDT
White Knight releases *SpaceShipOne* at 47,100 feet. Seconds later, the pilot fires the rocket motor.

6 The tail booms return to their level positions at 51,000 feet, and *SpaceShipOne* glides back to Mojave Airport.

2,791 feet
Mojave Airport elevation

ART BY DON FOLEY. NOT TO SCALE

a spacecraft and rocket into orbit, even vacation on the moon. By the mid-1990s, however, I'd realized that waiting for NASA wasn't going to work. The government's attempts to reduce the cost of space access had led to billions of dollars being spent on design studies and a few research craft. If my dream was going to come true—of floating weightless in the black sky and being thrilled by the sight of Earth from outside our atmosphere—I'd have to get things started myself.

I was encouraged to do this by the history of aircraft design itself. Five years after the Wright brothers' first flight, in 1903, the airplane was still just a dangerous curiosity. Only a dozen or so people had ventured into the air. Yet by 1912 hundreds of pilots had flown a number of different designs developed around the world, with crashes weeding out the bad ideas. Soon factories in France, England, and Germany were producing hundreds, and then thousands, of airplanes a year. Why? I believe the answer lay in two observations: "That's gotta be fun" and "maybe I can do that."

Clearly, if private spaceships were going to be built, they would also need to be created for fun by those discovering that "maybe I can do that." My theory was about to be tested as I stood inside our mission control room at Mojave Airport. By now *White Knight* had carried *SpaceShipOne* to its launch altitude of 47,100 feet. The moment of truth was at hand.

Inside *White Knight,* flight engineer Matt Stinemetze released *SpaceShipOne* from its hooks, and Brian Binnie, inside the smaller rocket ship, called out "arm and fire." The

motor ignited and 18,000 pounds of thrust threw Brian back in his seat at three times the force of gravity.

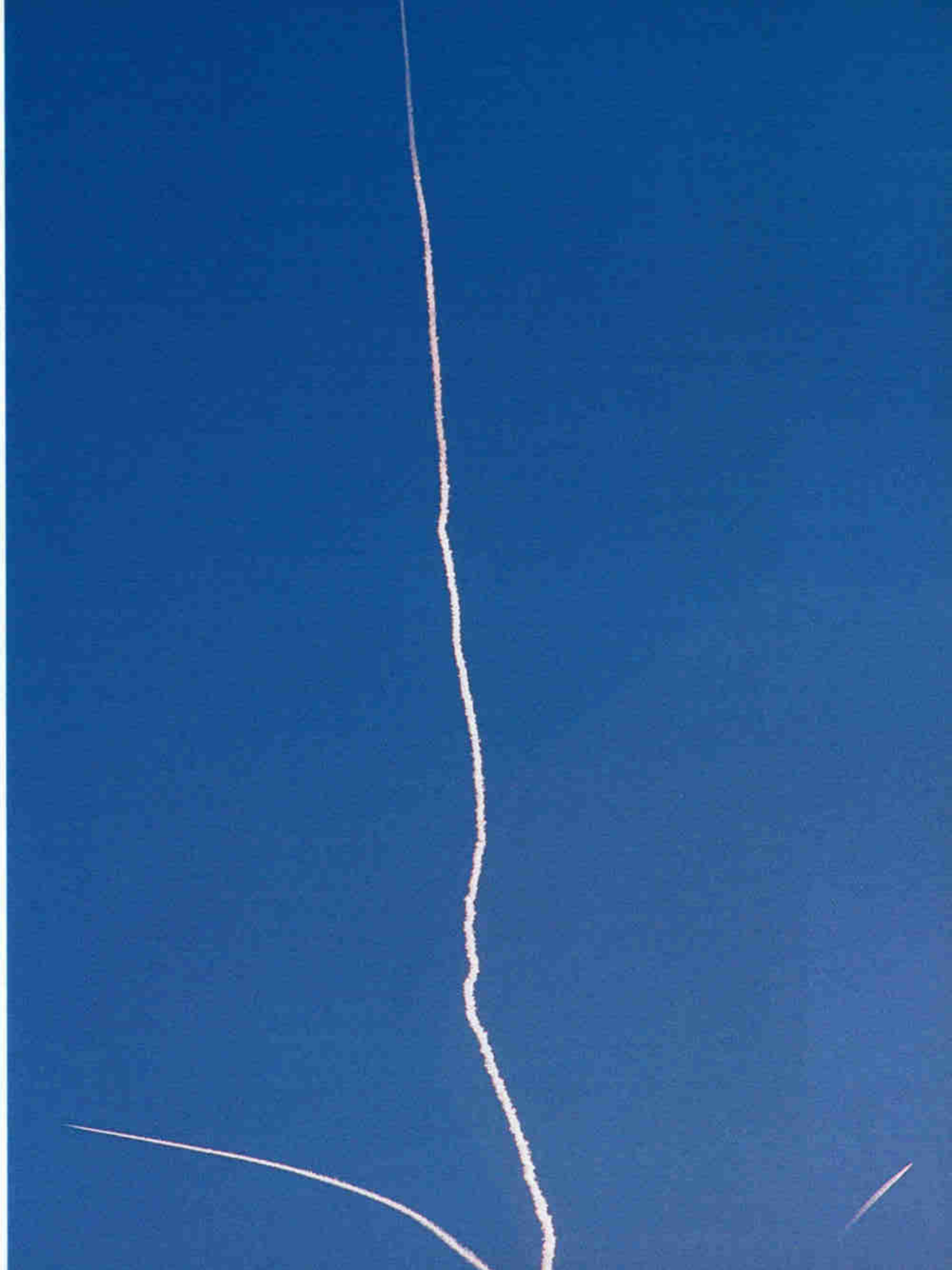
In about ten seconds he broke the sound barrier and began a steep climb that would take him into the record books: Not only did he fly smooth and true, he also broke the unofficial world altitude record set 41 years before by the North American X-15. And he broke it by 13,000 feet! Brian topped it all off with a picture-perfect landing at Mojave Airport 24 minutes after he had ignited *SpaceShipOne*'s rocket engine.

Winning the X Prize didn't mark the end of our fairy tale; it was merely a very good beginning. I'm committed to continuing research into sub-orbital flight to ensure that it can be done far more safely than any past manned system. Affordability is necessary too, so that many thousands can fly, not just ten or so astronauts or cosmonauts a year. I know this will be a challenge; we need major technological breakthroughs to make such visions come true. But the same could have been said of S*paceShipOne* a few years ago—and look at how far we've come.

Already, Richard Branson, head of the Virgin Group, has announced that he will license the *SpaceShipOne* technology from investor Paul Allen, who has financed my endeavor all along. Branson is investing about a hundred million dollars to create the world's first spaceline, Virgin Galactic. My company, Scaled Composites, will work under contract to Virgin to build the first few spaceships, which may begin commercial operations by the end of the decade.

And guess who will be on that first commercial flight? Yours truly. But we won't stop there. Branson has stated that he plans to reinvest his Virgin Galactic profits to continue funding research that will result in new flight systems that could take people to orbiting hotels or a lunar landing base. And guess who will be on one of those flights? You. Or perhaps your children. If you're a space dreamer like me, then believe it when I say that you're waking up to find that it's really happening. □

IN THE PILOT'S SEAT Enjoy a 360-degree view from inside the cockpit of *SpaceShipOne*, then join our Forum on the future of space flight and cast your vote on whether you'll be able to visit space yourself at **nationalgeographic.com/magazine/0504.**



Spectators Nikki LeFebvre and Kathryn Kightlinger (left) spy the streaking rocket during its ascent, as *White Knight* peels left and a chase plane curves right. Later, the team salutes the crowd in front of *SpaceShipOne* with a flag carried aboard the historic flight.

Winning the X Prize was merely a very good beginning.

CELEBRATING THEIR SUCCESS (FROM LEFT): X PRIZE SPONSORS ANOUSHEH AND AMIR ANSARI, X PRIZE CHAIRMAN PETER DIAMANDIS, INVESTOR PAUL ALLEN, BURT RUTAN, BRIAN BINNIE, AND RICHARD BRANSON

seaGypsies

In island-dappled waters of the Andaman Sea, a

sies of Myanmar

nomadic way of life hangs in the balance.

Flotilla at rest: As the rainy season nears in late April, boats of the nomadic Moken people bob gently in the warm shallows off Nyawi Island in the southern Mergui Archipelago. Some Moken camp here during the summer rains, though this flotilla will travel farther south. In the eight to nine months spent at sea each year, some cover over a thousand miles on the sea. A single boat occasionally ventures off from the group so an individual can dive for tradable sea trinkets like shells and sea stars (previous pages), seek a lover, spouse, or healer, or join another flotilla for a ritual before returning to the extended family.

By JACQUES IVANOFF

Photographs by NICOLAS REYNARD

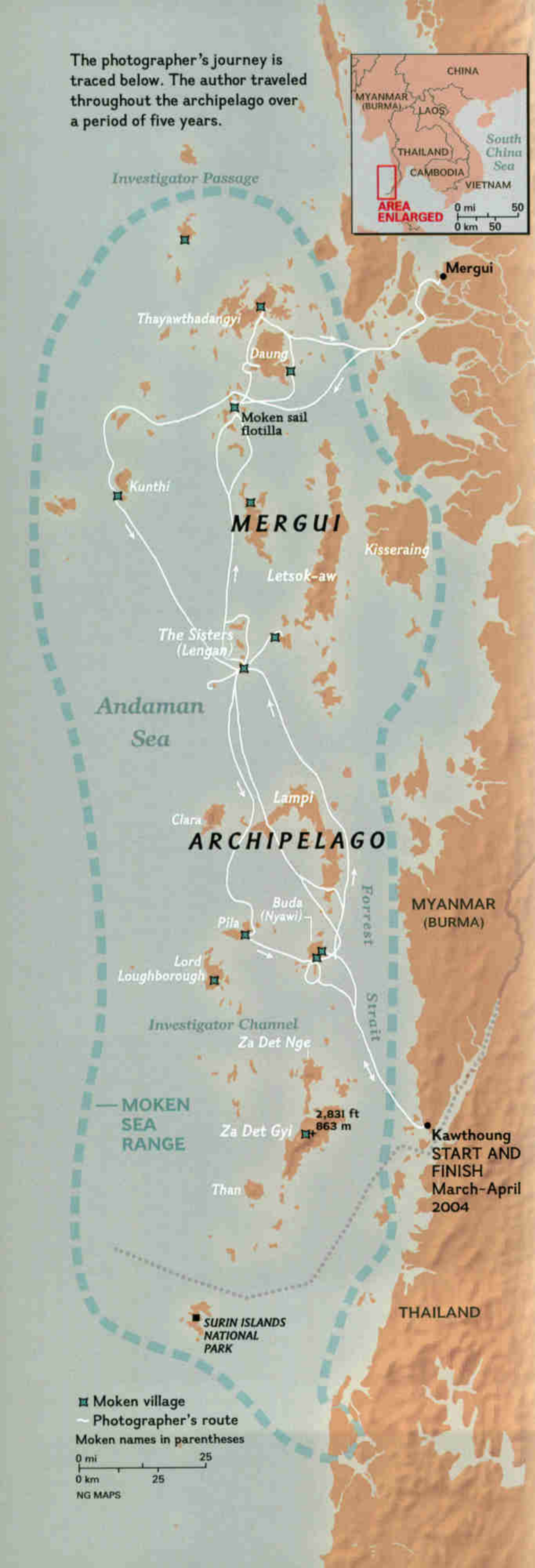
On the horizon we see them, their flotilla of small hand-built boats, called *kabang*, like a mirage beneath the setting sun. They are wary of strangers: At our approach they split up and scatter. We close in on one boat, and I call out reassuring words in their language. The boat slows and finally stops, rolling on the swell in heavy silence. I jump aboard, a privileged trespasser and rare witness to another world.

That world belongs to the Moken, a nomadic sea culture of Austronesian people who likely migrated from southern China some 4,000 years ago and, moving through Malaysia, eventually split off from other migrant groups in the late 17th century. Their home is the Mergui Archipelago, some 800 islands scattered along 250 miles of the Andaman Sea, off Myanmar (formerly Burma). For decades piracy and Myanmar's military dictatorship kept outsiders away. With special permits to work in the area I too am a nomad on these waters, having followed the Moken for years to hear their stories and learn more about their culture.

It is an elder named Gatcha who allows me on his family's boat and listens to my plea to join them. I have a long history here: My father, Pierre Ivanoff, worked with the Moken starting in 1957, and I reestablished that relationship in 1982, several years after his death. I tell Gatcha that I've lived among his people, that I befriended their greatest shaman and recorded hours of his myths and tales that I wish to share. When Gatcha finally offers me a plate of betel nuts, I know he has accepted me.

"The Moken are born, live, and die on their boats, and the umbilical cords of their

Quarters are close and possessions few on a *kabang*, which usually houses five or more relatives. These boats represent the human body: Inside, Moken cook, eat, sleep, and give birth. This couple and their baby live with the mother's parents while awaiting a vessel of their own—which the community will help build.



children plunge into the sea," goes an epic of the Moken. For eight to nine months a year they live aboard their low-slung kabang—punishment, according to the myth, laid upon the society by an ancestral island queen, Sibian, when her husband, Gaman the Malay, committed adultery with her sister. The queen declared that the kabang would represent the human body, with the front of the boat a mouth constantly seeking nourishment and the back an anus for defecation.

As divers and beachcombers the Moken take what they need each day—fish, mollusks, and sandworms to eat; shells, sea snails, and oysters for barter with the mostly Malay and Chinese traders they encounter. They accumulate little and live on land only during the monsoons.

The wave troughs look immense from the kabang, but Puket—one of Gatcha's seven children—sits in the stern calmly smoking his pipe amid the exhaust of the motor. Puket and another son, Jale—a mighty spear fisherman—and a daughter named Iphim, a childless widow, travel with their father most of the time. This family, like all Moken, poses little threat to others sharing these waters. Apolitical and nonviolent, Moken keep to themselves except when trading, usually on the move in flotillas of seven or more kabang belonging to an extended family. Still, our lone vessel is stopped by a Burmese military boat disguised as a trawler. Fortunately, we are sent on our way without incident, and Puket even manages to beg a few fish and some liquor by flattering the officials.

But it is not always so. The Moken have been exploited and harassed throughout history by the British, Japanese, Thai, and Burmese alike. They've been stopped to pay taxes, driven away by illegal fishermen, forced to work in mines and on farms, prohibited from vital trading areas, jailed for lacking permits, even turned into opium addicts by merchants to keep them dependent. Recently the Myanmar government, following Thailand's lead, has tried to settle the Moken permanently in a national park as a tourist attraction.

The Moken have resisted, but threats to forcibly settle them still hang in the air. And other troubles abound. Their own demography could destroy them: Many young men die

"Oh! Young man, may the wind fill your sails. I ask the seven gusts of wind to come and blow. May they push the boat of the young man who is going home." The Moken epic refers to sails made of pandanus leaves. Most kabang today run by motor: This sail, a plastic one, is the first the author saw in use on the water during his years studying the Moken.

each year in diving accidents—often from the bends when they dive too deep and resurface too quickly while working for Burmese fishermen. As the military presence increases throughout the islands, the Moken are unable to move freely in search of spouses. And without room to roam, they cannot find the traders who provide rice—the staple Moken *food*—and fuel for their motors. Ten years ago, some 2,500 Moken still led the traditional seafaring and spiritual life in this archipelago. That number is slowly diminishing and is now at perhaps 1,000.

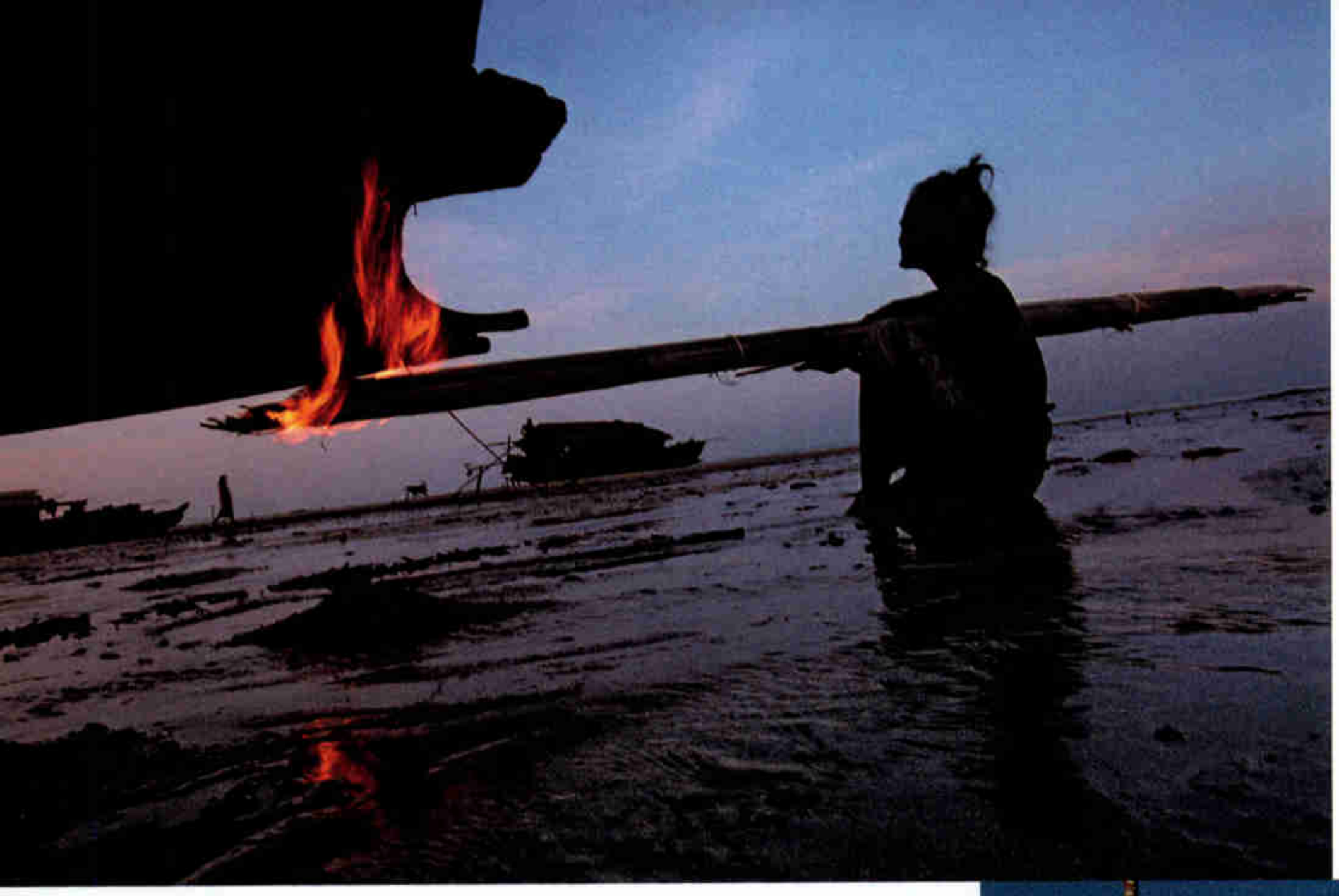
As the son of a shaman and a father figure to his people, Gatcha's mission is to keep the old ways alive, bringing the Moken together for rituals that have suffered as flotillas have divided into subgroups and scattered north and south to reduce competition for natural resources. On this journey he will round up followers, including sacred singers and dancers to take with him to Nyawi Island, where things have gone awry. Soldiers are harassing the Moken and Burmese there, and the Burmese government has mandated a Moken festival for tourists—which Gatcha says is upsetting the spirits. With offerings, trances, song, and dance on Nyawi, he hopes his people can begin to appease the ancestors, to whom they look for guidance and protection.

The days of gathering end with a night of restorative ritual, after which I am heartened to see Gatcha and his family push out to sea in the damp, gray morning, continuing their journey through the archipelago. As the dry season nears its end, it is time to put down shallow roots on land, setting up a temporary camp in which to wait out the swift winds and rains of the monsoons. It will be a place to honor the spirits and to build new boats for young men coming of age.

The island chosen for a monsoon camp offers a breathtaking setting: A wall of virgin forest—rife with boar and bats to be hunted—a band of beach, and a deep, powerful sea. Women comb the beaches and sing, and children play in the surf. Girls coax sandworms from hiding with rattan sticks; boys fashion harpoons and learn from the older men how to hunt for fish, crab, turtle, ray, and eel.

The Moken are the soul of this archipelago, the expression of a world that has begun to fade. My hope is that as the rains continue to come and go, so too will the Moken, from sea to land and back again.

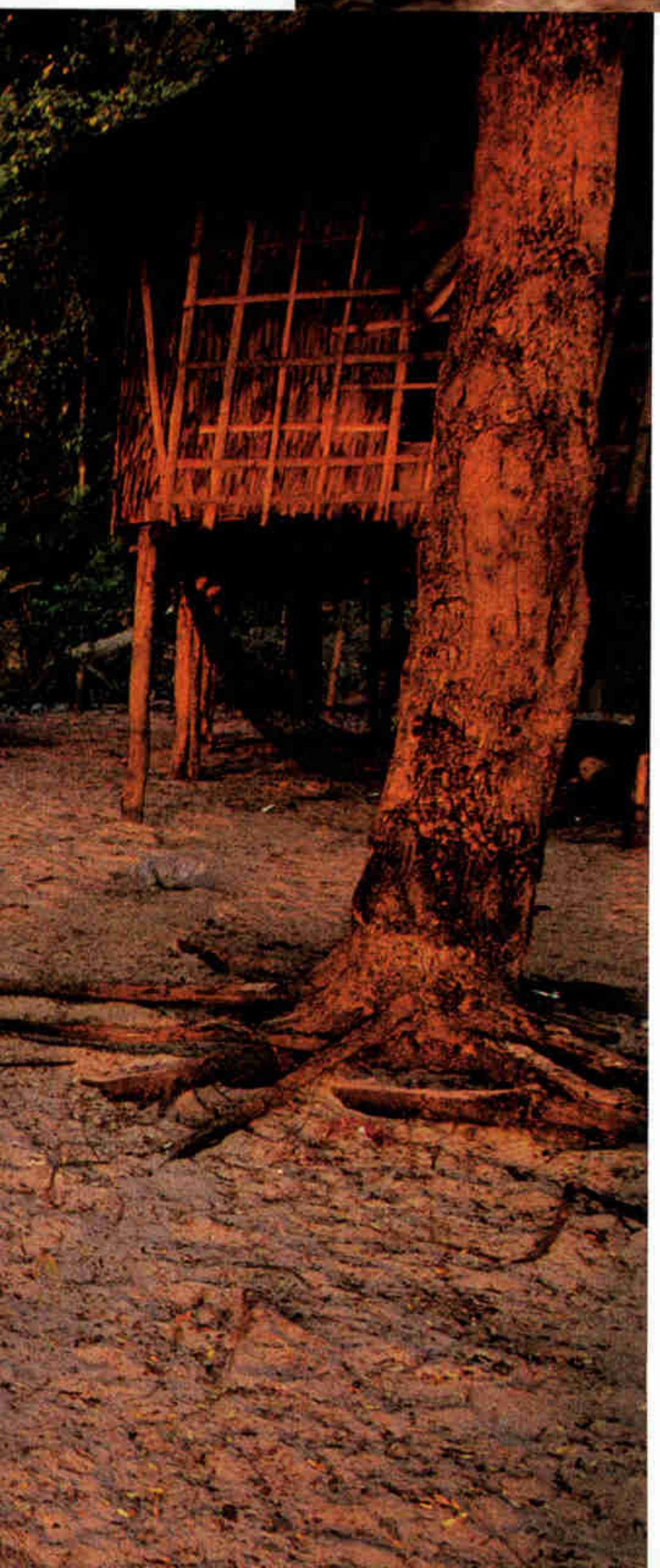
SURVIVORS AT SEA How has the tsunami affected the Moken? Get the latest news online, then explore the Sights & Sounds of the diminishing world of these seafaring nomads at **nationalgeographic.com/magazine/0504.**



By necessity the Moken straddle two worlds: They have embraced the sea and befriended the land, both vital to their survival.

Preparing for the rains It is as inevitable as the sunrise: The monsoons, which turn the Andaman Sea ferocious and unnavigable, are coming. During the worst of the wind and rain, mainly in May, June, and October, the Moken take refuge on land—some here on the Lengan Islands. Men and women, young and old, comb the forest for wood, bamboo, and pandanus leaves for building temporary houses (below). Old boats receive special care: Barnacles and algae that accumulate on the hull during months at sea are burned off with a smoldering roll of pandanus leaves. It is also time to build new boats for young men and to gather sea life and shells that the tides uncover.

Renewing the spirit With shelters from the storm roofed and ready, the Moken turn to spiritual matters. Some carve and paint totems called spirit poles (below), statues used as conduits by a shaman to contact the ancestors in an annual ceremony that takes place during the last full moon of the dry season. Others procure honey (right), a delicacy offered both to the ancestral spirits and to living Moken. Usually a honey gatherer coats himself in mud and fills his nose and ears with leaves before smoking out a hive and collecting its riches. This bare-chested elder on Nyawi Island did neither, facing the angry bees without protection. He emerged without a single sting.



Their ties
to land are
temporary
and their
possessions few.
If the Moken
had wealth,
they'd be
attacked,
so they
take just what
they need.

Natural resources The Moken are fed from the sea, hunting with harpoons, hooks, and hands rather than fishing with nets and lines. The kabang that define them come from the forest: A keel from an old-growth trunk is roughed out where the tree falls before being hauled to the beach (right); the boat may take four months to complete. Also hand-carved of wood, traditional goggles were fitted with found glass and sealed with tree sap. Plastic eyewear is now more common.

Creature of many meanings, the turtle—this one taken alive for a Moken ritual—symbolizes all women: daughters, sisters, and especially the life-giving mothers. To harpoon a turtle is to marry a woman. The most important Moken rituals involve turtles, a food that everyone shares, and, like the Moken, the turtle lives between land and sea.

The Moken spirit pole festival reunites the flotillas into one heart, one soul.

Connecting to the past The ancestors are summoned during the annual spirit pole festival. For weeks ahead of time the Moken gather ritual offerings, including cakes of rice flour, alcohol, betel nuts, and cans of soda —whose bubbles represent life-giving wind. It is a joyous day of song and recitation, led by a master of ritual (below, with red scarf). Here he also acts as the shaman who, in a trance, tastes the head, blood, and flippers of a fresh turtle (left) and asks the ancestors for favors, translating their replies for the community. The Moken have faced pressure to accept other faiths, such as Christianity, Buddhism, and Islam, but many have refused, retaining their animistic beliefs.

Safe harbor A flotilla waits in a sheltered cove for the rising tide. Here off Myanmar the Moken still come and go, though under ever tightening restrictions. The fate of the Thai Moken is already sealed: The government forced that population of nearly 200 to settle in Surin Islands National Park as a tourist attraction, and their boatbuilding and navigation skills may be lost. As tourism grows in Myanmar, so too does political pressure for a similar settlement. How much longer will these nomads be left to roam?

The tsunami of December 26, 2004, devastated the coasts of Myanmar and Thailand. All but one person in the largest group of Thai Moken, settled in Surin Islands National Park, escaped with their lives by running to high ground—although they saw their village and their boats demolished. The fate of the nomadic Moken in Myanmar is uncertain. Aid workers report greater casualties and damage than the government; the tsunami's full impact on this population could take months or even years to trace. □

NATIONAL GEOGRAPHIC RESEARCH AND EXPLORATION

GRANTEE
Raoul Mulder
Biologist, University of Melbourne, Australia

"Why did evolution produce two such different male colorations in this bird? It's fascinating, and there isn't an obvious answer."

Eleven-day-old paradise flycatcher chicks beg their father for a bit of food. Some male flycatchers are white and black while others, like this one, have a reddish hue. Such a dual palette among male birds of the same species is extremely rare.

birds of a different color

Madagascar's Paradise Flycatchers

THE PROJECT

DATE: 1996 to present
PLACE: Bealoka reserve, Madagascar
GOAL: To discover why dichromatism evolved in male Madagascar paradise flycatchers *(Terpsiphone mutata)*
RANGE OF BIRDS:
Madagascar, Comoro Islands
PERILS TO RESEARCHERS:
Thorny plants, feisty wasps

By John L. Eliot
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by Cyril Ruoso

In the dry southern tip of Madagascar, an aging bridge crosses what's left of the Mandrare River, now throttled by silt from deforested lands upstream. The bridge leads to a lush 300-acre patch of forest known as the Bealoka reserve. Some of it is dark and gloomy, cloaked by a high canopy of tsatsake trees. Sunlight filters through more open parts where tamarind trees grow. Throughout the forest echo the calls of about a hundred bird species.

One of the most recognizable is the harsh *retret retret* of the Madagascar paradise flycatcher. Males are visually unmistakable, with tails three times their body length streaming behind them—and with a colorful twist that has drawn biologist Raoul Mulder to camp in Bealoka for parts of the past nine years.

Adult male Madagascar paradise flycatchers come in two distinct color types, or morphs, a rare phenomenon among birds. (Males of only one other known bird species, a Eurasian sandpiper called the ruff, have such color variations.) One flycatcher morph, the rufous type, is reddish brown; the white

Taking to the air for science, researcher Ernest Rasombinirina (left) climbs to a nest to retrieve flycatcher chicks for banding. A week-old chick (top) wears a blue numbered tag on its leg. Mulder (above) gently removes a flycatcher from a net before banding it. He and his team have already logged more than 1,500 individuals.

morph is mostly white and black. Once these plumages emerge—after about three years or so—they're permanent. But why the two different hues?

In nature, color evolves in part to attract mates. If one male flycatcher color had a mating advantage, the other should have gone extinct. It hasn't, so each color must provide some sort of benefit—and that's where things get complicated.

It's possible, says Mulder, that female flycatchers choose to mate with whichever morph type is *less* common at the time, a form of sexual selection known as the rare-male effect.

Geographic location may also play a role. One morph color may stand out better—and thus attract more females—in bright, open spaces, while the other may be more visible in dense shade. But he who gets the most dates may also die young, because the morph color that females prefer may also be more visible to forest predators.

Mulder thinks the white morph is more susceptible to predation. "Our color measurements show that white morphs are more conspicuous than rufous males," he says. "We've set up trials using stuffed mounts of both male types. The white ones are always attacked first. The predators are sparrow hawks, and we've seen them kill white males."

He who gets the most dates may also die young.

So, do females prefer their mates in white? "Since white males suffer more predation, you might expect them to have a mating benefit to compensate for this cost," says Mulder. "But the data suggest that females are highly unfaithful to *both* male types."

In breeding season, a female lays up to three eggs on consecutive days. Though she pairs with one male that helps tend the nest, she may also copulate with males in nearby territories and can store their sperm, so each egg could be fertilized by a different father.

Using DNA analysis, Mulder and his team have determined the paternity of some 700 nestlings. Half the nests held chicks fathered by different males of one or both colors. "Females apparently do not have fixed preferences for particular males or morph types," says Mulder. In future studies he hopes to detect paternity patterns that may shed more light on the mystery of flycatcher color. □

A chick struggles to swallow a dragonfly offered by its mother, who displays the short tail and red hue of all females. A white-morph male (above) brings food to his brood. Mulder hopes to learn whether females prefer red mates or white.

SARTORIAL SPLENDOR Learn more about these visually elegant birds through links and resources at **nationalgeographic.com/magazine/0504.**

CIVIL WAR

ALEXANDER GARDNER, LIBRARY OF CONGRESS, PRINTS AND PHOTOGRAPHIC DIVISION, CIVIL WAR PHOTOGRAPHS

Saving the Landscapes

BATTLEFIELDS

of America's Deadliest War

CONFEDERATE DEAD LITTERED THE BATTLEFIELD OF GETTYSBURG, where a Union victory helped turn the tide of war. Today a car lot sits within Gettysburg National Military Park. But the lot will soon be removed and the land restored to how it likely looked in 1863—one small victory in the raging fight to save the Civil War's bloodstained lands from vanishing under sprawl.

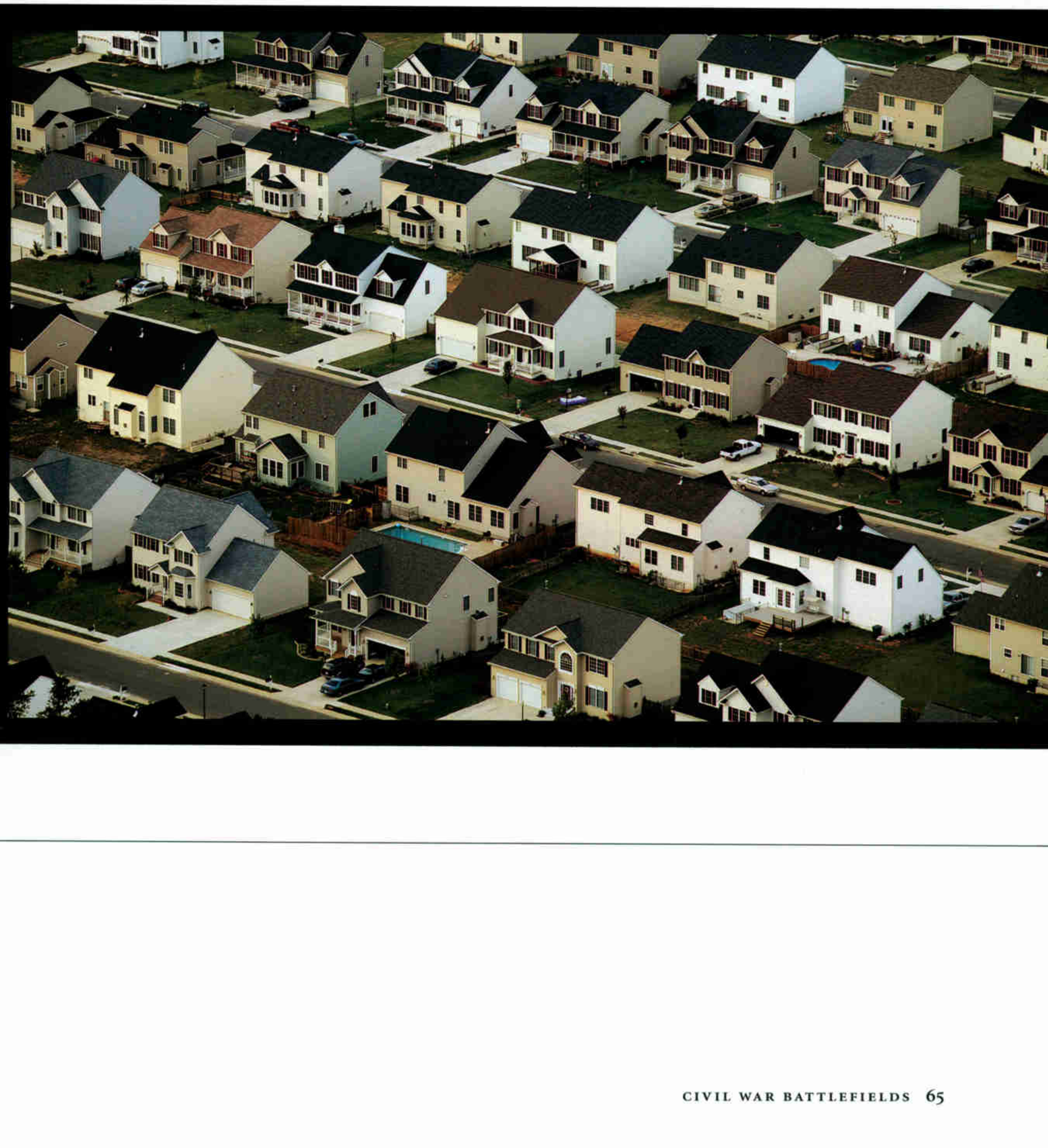
ANDREW J. RUSSELL, CHICAGO HISTORICAL SOCIETY

Spotsylvania region, Virginia · 1862-1864

CASUALTIES* **UNITED STATES (U.S.) 67,753** **CONFEDERATE STATES (C.S.) 40,776**

*INCLUDES KILLED, WOUNDED, CAPTURED, AND MISSING IN ACTION

"THIS IS GROUND ZERO FOR PRESERVATION," says Jim Campi with the Civil War Preservation Trust, a group working to save land in areas such as Spotsylvania County (below), where lower home prices lure newcomers—and sprawl covers battle sites. Union troops (left) clashed with Confederates throughout the region, midway between the wartime capitals of Richmond and Washington. "If battlefields here aren't saved in the next five years, they're gone," says Campi.



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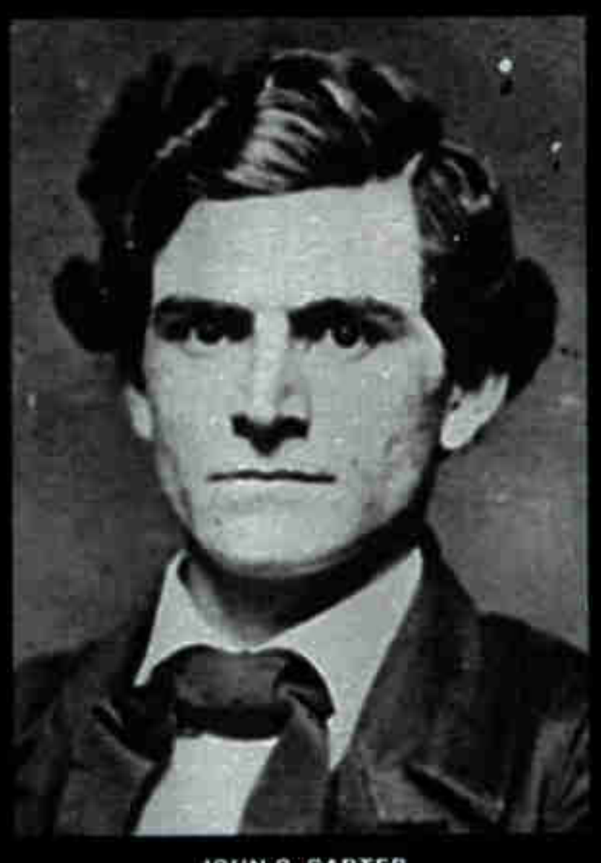
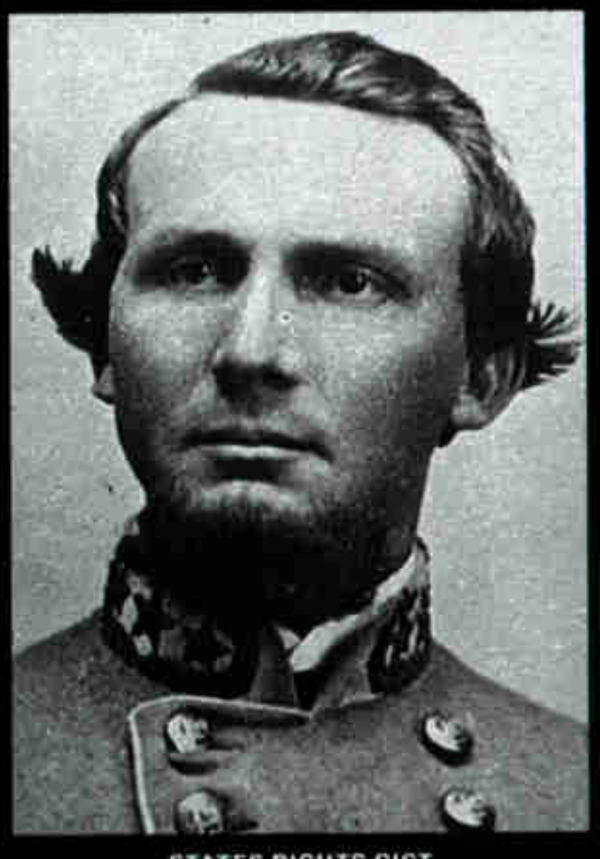


JOHN C. CARTER

HIRAM GRANBURY

PATRICK CLEBURNE



STATES RIGHTS GIST

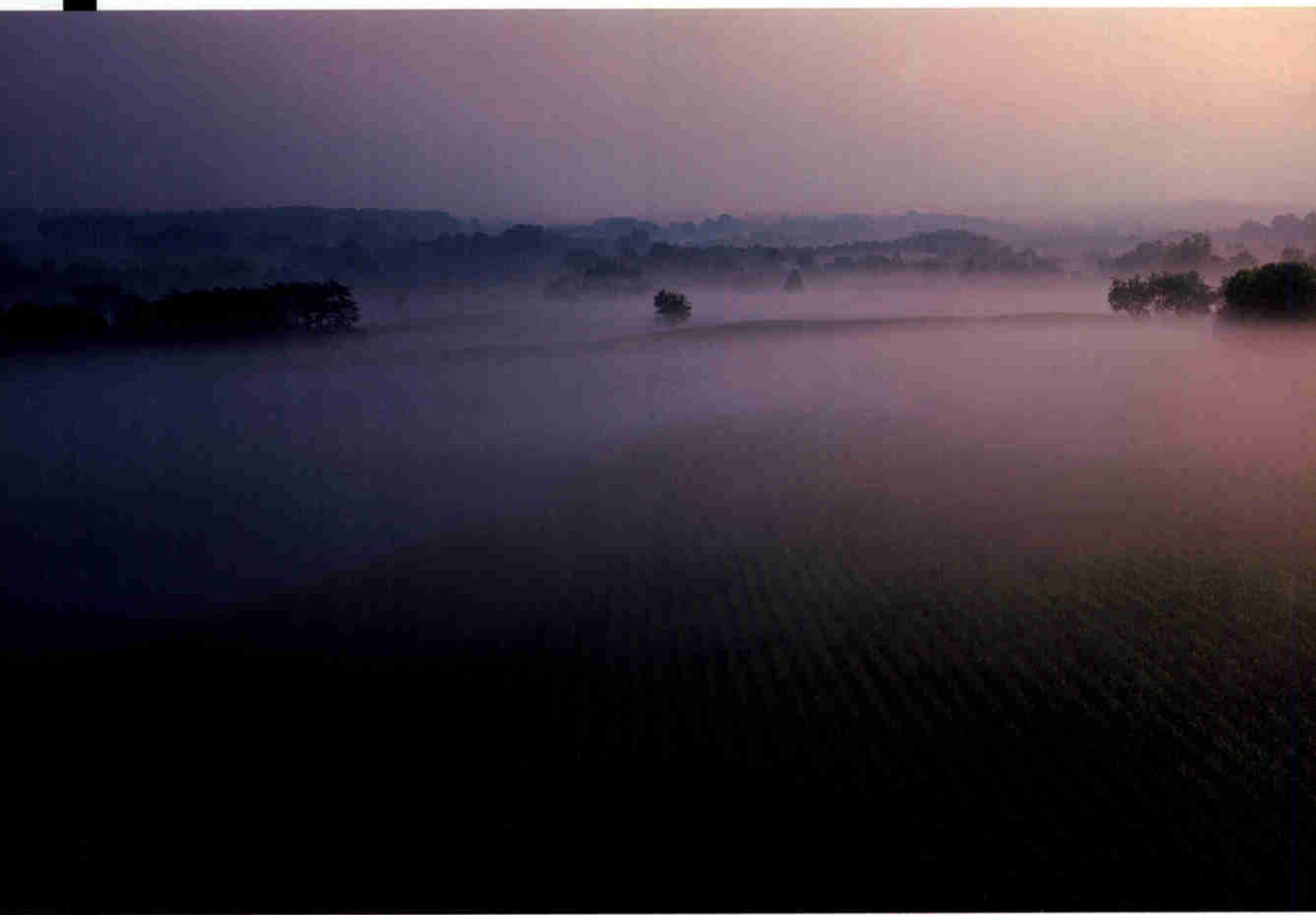
BINGHAM BROTHERS, TENNESSEE HISTORICAL SOCIETY (STRAHL); TENNESSEE STATE LIBRARY AND ARCHIVE (ADAMS, CARTER, GRANBURY, GIST); MUSEUM OF THE CONFEDERACY, RICHMOND (CLEBURNE)

Franklin, Tennessee · November 1864

CASUALTIES U.S. 2,326 C.S. 6,261

THE SAVAGE BATTLE OF FRANKLIN raged into the night, leaving six Confederate generals dead (left), eight wounded, and one a prisoner. Now a Pizza Hut lights the epicenter of the struggle. Residents of this Nashville suburb are raising millions of dollars to buy part of the battlefield. "Why do we want to save it? Because in the South's loss at Franklin, all of us won," says activist Robert Hicks. "This is where the Old South died, and we were reborn as a nation."

"Generations that know us not and that we know not of, heart-drawn to see where and by whom great things



BY ADAM GOODHEART PHOTOGRAPHS BY MICHAEL MELFORD

Dawn creeps low and stealthy over the fields of Virginia, a haze of pale gray tinged with fire. Slowly, too, my comrades-in-arms rouse themselves. Along our line of trenches, men and boys yawn, scratch at the heavy wool of their dew-soaked uniforms, and huddle over the few embers that have smoldered through the night. A ragged double file of Georgia infantrymen slouches against rifles as a caisson rattles past.

Then the sharp crack of gunfire breaks the morning's stillness. "Everybody down!" yells our startled lieutenant. Across the field before us sweep the Yankee skirmishers, and behind them a denser wave of blue moves with startling speed. The massed forces of the Union Army charge at a dead run toward the center of our Confederate earthworks. Our men load and fire as fast as they can, tearing paper cartridges with their teeth

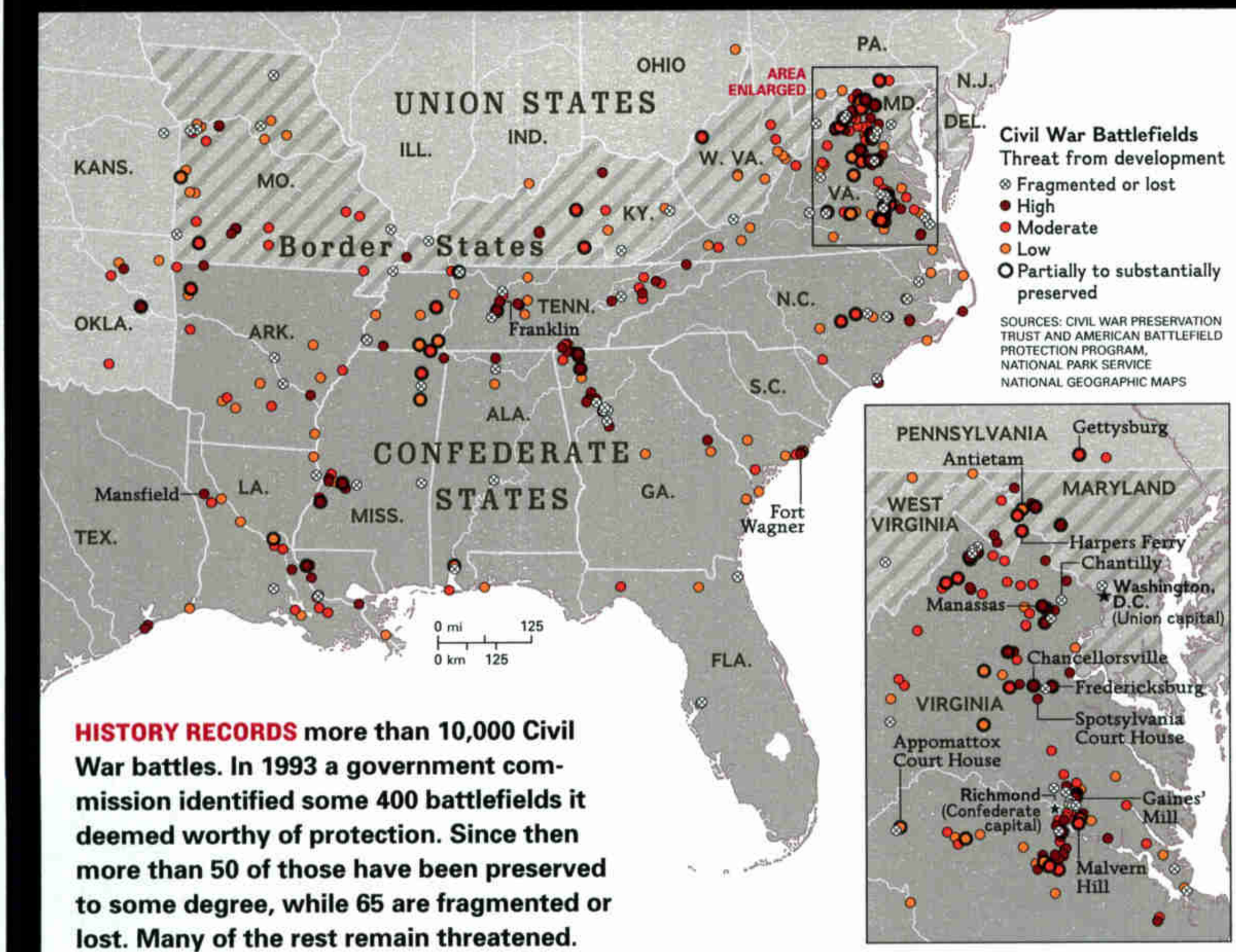
suffered and done for them, shall come to this deathless field, to ponder and dream." —UNION GEN. JOSHUA L. CHAMBERLAIN

as the woods behind us echo with the crashing volleys. But still the Federals come, the officers' swords flashing as they rally their men forward.

I enlisted in the Fourth Georgia Infantry only yesterday, when I traded my sweater and jeans for the battered slouch hat, too-tight shell jacket, and dirt-stiffened gray trousers that one of my new comrades produced from deep in the trunk of his Pontiac Bonneville. Together with some 4,000 Civil War reenactors, I've come to a historic Virginia farm to relive the Battle of

ROW ON ROW OF SOLDIERS were slain on this Antietam cornfield, scene of the bloodiest one-day battle in American history. Now enveloped by 15,000 protected acres, the Maryland site remains as soldiers saw it.

Spotsylvania Court House, which was fought in May 1864. In real life the combatants are schoolteachers and cell phone salesmen, teenage history buffs and paunchy suburban dads. But now, amid the clamor and confusion of the dawn



HISTORY RECORDS more than 10,000 Civil War battles. In 1993 a government commission identified some 400 battlefields it deemed worthy of protection. Since then more than 50 of those have been preserved to some degree, while 65 are fragmented or lost. Many of the rest remain threatened.

assault, the 21st century dissolves and we are all inhabiting another century, another America, wild and strange—a place of blood and thunder, reeking of burned powder and churned mud.

I try to carry those sensations with me later in the day as I leave the reenactors' camp and drive some ten miles to the place where the actual Battle of Spotsylvania was fought, but it isn't easy. Still dressed in my faded uniform, I sit in backed-up traffic along Route 1, a fumy strip of asphalt lined with gas stations, fast-food joints, and car dealerships. As I enter the once sleepy, now suburban village of Spotsylvania, my first glimpse of the battlefield is of the neat headstones of a Confederate cemetery—behind the parking lot of a 7-Eleven.

Traveling among the nation's Civil War battlefields today is a disorienting experience, constantly beset with such slippages between the present and the past. From New Mexico to Pennsylvania, many of the places where the Union and Confederacy clashed are now caught up in another struggle between a quickly vanishing America of small farms and crossroads villages and a newer landscape of megamalls and sprawling McMansions. Places that were at the front lines 140 years ago—Manassas, Antietam, Gettysburg—are at the front lines again today. Exactly at a moment when Americans seem more interested than ever in finding connections to the wartime past, much of that past is in danger of being lost.

Nowhere is this more true than in Spotsylvania County, a place whose location has cursed it before. After the South seceded, this bucolic region found itself dead center between the warring capitals of Washington and Richmond. In all some 108,000 soldiers were killed, wounded, or captured in this one county, more than ten times as many as on the D-Day beaches in World War II. By the end of the war in 1865, the land was furrowed with earthworks, the inhabitants scattered, and the battle dead lay buried in cornfields and farmyards.

It took Spotsylvania almost a century to regain its prewar population of 12,000 residents.

But since the 1960s that population has multiplied nearly tenfold as the county—less than an hour down Interstate 95 from Washington, D.C.—has become, in the words of one local, "a bedroom community for Yankee bureaucrats." Today a new crop sprouts in the former cornfields: row upon row of cookie-cutter houses. Much of the 1860s landscape has been obliterated, often by developments whose names give hollow echo to the Civil War's guns—Artillery Ridge, Lee's Parke.

Back in the 1920s the federal government created a national military park in Spotsylvania County—actually, a disconnected smattering of battlefield parcels that would eventually total more than 8,000 acres—but excluded many historically significant sites. "At the time they did this, they just assumed the area was going to remain rural forever," says John Hennessy, a National Park Service historian.

One morning Hennessy takes me for a drive out to Salem Church, a dignified old brick building that commands a ridge overlooking Route 3, once known as the Orange Turnpike. During the Battle of Chancellorsville in May 1863, Gen. John Sedgwick's Union troops, in hot pursuit of Robert E. Lee's army, were halted here by Confederates atop the hill. Hundreds of bullet scars on the church's walls still testify to the fury of the ensuing fight. But the ground that Lee's men fought to defend now sits beneath a Hardee's, a Chick-Fil-A, and an empty grocery store. The old turnpike that Sedgwick marched down is now a roaring eight-lane highway lined with malls and big-box retail stores. A granite Yankee, placed as a monument 45 years after the war, casts a stony gaze on Trivett's Family Furniture and the Old Country Buffet.

"This was still a quiet country road in the 1960s," Hennessy says. "The development here didn't happen in one fell swoop; it went in one project here, one project there. That's always the hardest kind to fight."

A few miles farther on we reach the site of one of the most famous battle maneuvers of the Civil War: Gen. "Stonewall" Jackson's brilliant flank attack in which he divided his troops from the rest of Lee's army and caught the much larger Union force completely by surprise—a move that won the victory at Chancellorsville, but cost Jackson his life. The battlefield here appears still much as it did in May 1863, with rolling pastures dotted here and there with a stand of oak trees or an old farmhouse. But just down the road, the owner of an 800-acre farm has been trying for several years to get county approval for a large-scale housing development. I sat in on a contentious meeting of the county's board of supervisors when it took public comments on the plan. The motley crowd of citizens in the packed hall reflected the changing character of Spotsylvania County, and of many places in America: sunburned farmers and well-heeled suburbanites, Sons of Confederate Veterans and kids in Cub Scout uniforms. The landowner, a local mortician named John Mullins, was on hand as well. For each person who spoke, the Mullins farm seemed to stand for a different and essential concern: property rights, highway traffic, the influx of outsiders, the future of tourism, the memory of the Civil War dead.

Afterward, in the parking lot, I fell into conversation with one of the local Sons of Confederate Veterans, a lean, gray-uniformed man—a sign painter in civilian life—named John Martin. I asked him why he'd come to the meeting. "Every Virginian needs to take a stand against losing these parcels of ground," he replied. "This is hallowed ground to us."

"Sounds a lot like 1861, doesn't it?" I asked.

Martin thought for a moment, then laughed. "It sure does," he said.

If the romantic and perhaps doomed cause of saving America's Civil War battlefields can be said to have its own Robert E. Lee—a strategist who time and again snatched victory from the jaws of defeat—he is a man named James Lighthizer. The only catch is that in person Lighthizer seems better to resemble Ulysses S. Grant, a hard-driving, cigar-chomping politico straight off the pages of a gilded age broadsheet. As president of the Civil War Preservation Trust, Lighthizer has become adept at fighting many foes on many fronts all at once.

The trust is a private group, which surprises those who think of Civil War battlefields as a national inheritance. Indeed, the federal government did start preserving battlefields as long ago as the 1890s, purchasing land at a number of major sites to create the first national military parks. Its efforts have continued, sporadically,

throughout the century since. But Congress never appropriated enough money to buy an entire battlefield—understandably, since no one in decades past imagined that places like central Pennsylvania or the Virginia Piedmont would ever require much protection from development. And so, slowly, some battlefields were lost.

Chantilly, Virginia, where in 1862 Lee and Jackson attempted to push the Federal troops out of northern Virginia, now sits beneath a suburban mall. Mansfield, Louisiana, the site of more than 4,000 Union and Confederate casualties in 1864, is being strip-mined by a lignite company. But the real crisis came in 1988, when a developer bought a large tract of privately held land at Manassas, Virginia, and unveiled plans to build a 1.2-million-square-foot shopping mall directly over the site of the Confederate lines and Lee's headquarters at the Second Battle of Manassas. The effort was defeated only at the cost of a 120-million-dollar appropriation from Congress. Clearly it was time for preservationists to take the offensive.

The tide began to turn at Antietam—just as it had for the Union Army in 1862. On our way to the battlefield one bright morning, Lighthizer keeps up a running narration as he pilots his big maroon sedan up the same road that the Federal Army took through the Maryland hills. "That farmhouse was there during the war," he says, gesturing with his unlit cigar as we pass the place. "D. H. Hill, a Confederate general, looked out that window at the Yankees coming up the hill like a long blue snake and said he felt like the loneliest guy in the world."

By the 1990s the suburbs of Washington were also creeping, snakelike, toward the battlefield. Lighthizer was then transportation secretary for the state of Maryland, a job that gave him early warning of the threat. In classic backroom fashion he found millions of dollars that had been earmarked for "highway beautification" in a

REENACTORS NICK DUVALL (LEFT) AND JEREMIAH HORNBAKER, BY ROBERT SZABO

federal law and started spreading the money among the local landowners—sometimes purchasing the threatened acreage outright, more often buying easements that would maintain it as farmland forever. It's a strategy he has continued at the Preservation Trust.

These days, Lighthizer says, the trust is fighting in several dozen different places, a list that reads like a regimental battle roster—Morris Island, Franklin, Gettysburg, Harpers Ferry, Gaines' Mill. But it's a war that won't last forever. "We estimate there's about 200,000 acres of privately held battlefield land left," he says. "We're losing about 10,000 acres a year, so do the math. In less than 20 years, it's over."

Capt. Tod Carter's war ended where it had begun. In the spring of 1861 the blue-eyed 21-year-old left his father's farm near Franklin, Tennessee, and enlisted in Company H of the 20th Tennessee Infantry. He served through three years of hard fighting, was captured, and escaped. In the late autumn of 1864, as the Army of Tennessee, barefoot and famished, prepared for its last major struggle against the Federal troops, the tide of war swept Carter's regiment

FAKE BULLETS BUT REAL PASSIONS fly as Civil War enthusiasts re-create the Battle of Spotsylvania. Hand-sewn uniforms, reproduction revolvers, and a century-old tintype camera turn reenactors into stolid Yanks (left).

back toward Franklin. He could see the Stars and Stripes waving on the hilltop beyond his family's house, which had been commandeered as a Union headquarters. Far to the right and left stretched long lines of blue.

Late on the afternoon of November 30th, Carter mounted his horse, drew his saber, and rallied his men to the charge. He fell in a fusillade of bullets. Early the next morning, after the fighting subsided, he was laid on an old

overcoat and carried, still half-conscious, up the hillside to the house he had left three years before. Family tradition has it that he died in the back bedroom, and that his last words were "Home . . . home . . . home."

Of all the Civil War's major engagements, the Battle of Franklin is the most unjustly forgotten. It was a struggle at once magnificent and hideous. Both armies went in as though they knew it would be their last leap at glory. Some witnesses later recalled the battle flags waving along the lines, the bands playing jaunty airs in the heat of battle, the splendor of the Confederacy's full frontal attack. Others were haunted by grim visions of what followed: bodies stacked like cordwood, blood flowing ankle-deep. Nearly 9,000 men were killed, wounded, or captured in the space of just a few hours, including no fewer than 15 Confederate generals. It was perhaps the most concentrated slaughter of the entire war.

Today Tod Carter's house, still pocked with bullet holes, is a museum that sits amid a landscape of auto-muffler shops, fast-food restaurants, and low-rise shopping centers. The ground where he fell lies beneath a housing project. More than 1,700 of his rebel comrades were killed in the trenches and temporarily buried in a mass grave—now the site of a pizzeria.

Many have declared Franklin a "lost" battlefield. For a long time local people resisted attempts at commemoration. When the Park Service raised the possibility of buying land there decades ago, it was rebuffed. "The battle was viewed by many as an embarrassment," says Julian Bibb, a lawyer and town planner. "People thought of it as a huge Confederate debacle." It was also a sore spot for the local African-American community, which wanted no part of nostalgia for Dixie. And so, except for a few acres preserved by local groups, the battlefield was left to be engulfed by suburban sprawl from nearby Nashville.

That onslaught continues. Evan Kutzler, a 16-year-old high school student and Civil War buff, takes me one afternoon with his metal detector to hunt for relics of the battle. It's a hobby that demands the conscious erasure of the present, an ability to imagine what lies beneath. "This is where the Federal front line was," he says, pointing past a Goodyear Tire store. Nearby, in a drainage ditch next to a parking lot, he shows me where he once found a hundred bullets and a bayonet in a single afternoon. Many more artifacts are rumored to have come out of a field that's being bulldozed for a new Target.

Why does the Civil War continue to stir so many hearts? Why are the fields of long-ended battles still stalked by so

Most of the bodies from the Southerners' mass grave were later moved to a small private cemetery at Carnton Plantation, half a mile or so away. It's a beautiful place, with neat rows of small square headstones, many with the name of a dead Confederate. The names themselves tell stories. There's a Charles Chon, for instance, a Texas infantryman born in Shanghai, China, and a Joseph Lepseits, a Jewish lieutenant from western Tennessee.

These days the graveyard hardly lends itself to quiet reverie. Just over the fence are the parking lots and tennis courts of a local country club. On the graveyard's other side lies a different landscape: the gentle lawn of Carnton, which served as a hospital during and after the fighting and has been preserved by a local group. The Confederate cemetery seems stranded between two worlds, two centuries.

But that graveyard may soon become a place of rebirth. A wealthy preservationist has bought the country club for safekeeping until funds can be raised to create a historical park. On a Saturday morning in August, I sit on the back porch of Carnton overlooking the site with a group of civic leaders who are excitedly planning for the future. Mayor Tom Miller talks about the economic potential of bringing a national tourist attraction to the town. Thomas Murdic, an

African American who grew up in Franklin, says he sees an opportunity for racial healing by telling the whole story of the Civil War in the area, including the struggle of freed slaves. Robert Hicks, a Nashville music publisher turned preservationist, imagines undertaking what may prove to be "the largest battlefield reclamation project in North American history."

Why, 140 years after the Civil War's end, does it continue to stir so many hearts and rouse so many new struggles? Why are the fields of long-ended battles still stalked by so many restless ghosts? Part of the reason, no doubt, lies in the nature of the war itself, a struggle over slavery and freedom whose reverberations have continued to echo through American history, and whose consequences for African Americans have only lately begun to be honestly addressed.

many restless ghosts? Part of the reason lies in the nature of the war itself, a struggle over slavery and freedom.

Another piece of the answer comes to me when I reach Appomattox Court House. The Virginia village where Lee surrendered to Grant, in a green valley two hours' drive west of Richmond—a six-day slog for the ragged Confederates of 1865—is still a place of peace. Appomattox was preserved almost by accident, by one of those vagaries of the American economy that can leave a town stranded, high and dry as a beached ship. The railroad bypassed the town by three miles, and by the 1890s the once bustling county seat sank into obscurity.

Today Appomattox is a national park, and its remaining buildings sit amid fields of tall grass and stands of twisted old cedars. Even on a summer afternoon there are few visitors, and as I roam the village, the only sounds seem to be the hum of cicadas and the occasional sough of a logging truck that passes along Route 24. A reconstructed 1860s general store—the minimart of its day—displays barrels of molasses, bolts of calico, a rack of buggy whips. It seems to emphasize that this place sits above the high-water mark of 21st-century America, above the rising tide of chain stores and cardboard mansions. Perhaps not for long, for suburbia is spreading toward here too. But I realize now that the Civil War's battlefields are precious to us not just because of blood and heroism, but because they let us glimpse a vanishing, agrarian America—the very landscape in which our national identity was formed.

At long last, more and more communities are recognizing the value of this heritage. A month or so after the end of my battlefield journey, I learn that the Spotsylvania County supervisors approved a deal with the Preservation Trust that will save part of the Mullins Farm at Chancellorsville. Shortly after, word comes that the town of Franklin earmarked 2.5 million dollars in matching funds toward the purchase of the country club property. In both cases the preservation side used nimble battle tactics that might have made Lee himself proud.

Appomattox was as far as Lee got on his final, desperate retreat toward the shelter of the western mountains. On the night before the surrender, he heard the boom of cannon to the west and knew that Grant's men had outstripped him, had cut him off. Today, on a hillside above the village, the highway that Lee had hoped to follow, the old stagecoach route west from Richmond, is still visible. For a few hundred yards it has been reconstructed by the Park Service, a startling gash of earth like an open wound across the meadow. But then it dives beneath the turf again, and past the point where Lee turned back, it is visible only as a slight declivity in the earth, tufted with goldenrod and Queen Anne's lace—the merest memory of a road.

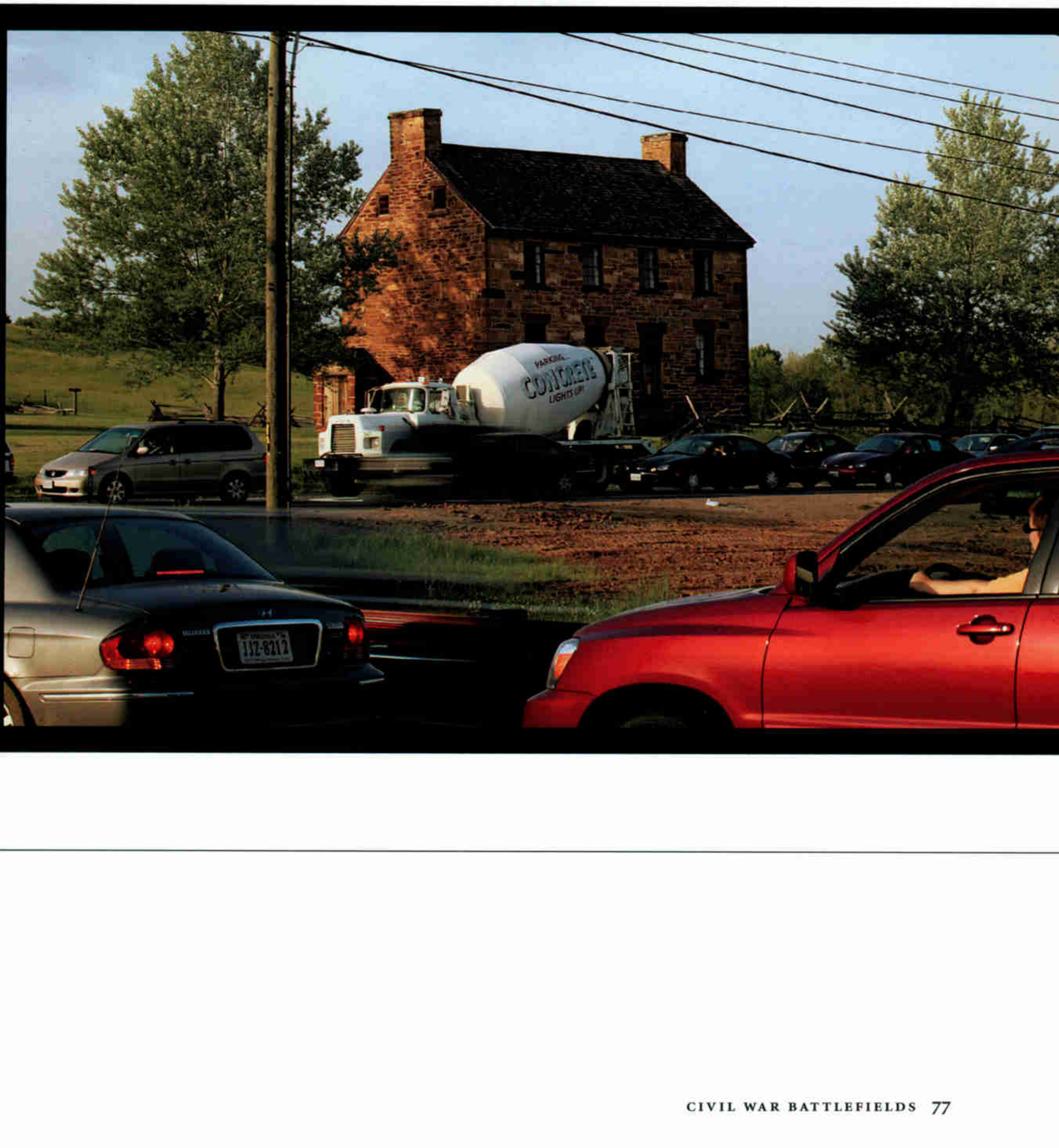
CIVIL WAR ON THE WEB Tap into a wealth of online resources, including links to national battlefield parks, reenactor groups, and the Civil War Preservation Trust at **nationalgeographic.com/magazine/0504**.

GEORGE N. BARNARD, LIBRARY OF CONGRESS, PRINTS AND PHOTOGRAPHIC DIVISION, CIVIL WAR PHOTOGRAPHS

Manassas, Virginia · July 1861 *& August* 1862

CASUALTIES U.S. 16,780 C.S. 10,100

TRAFFIC ARTERIES FLOW THROUGH THE HEART of Manassas National Battlefield Park, site of the first major clash between North and South. Columns of commuters file slowly past Stone House, a tavern that served as a field hospital during and after the battle. On most weekday afternoons, rush-hour traffic clogs spots that thousands of soldiers crossed en route to battle. Rangers advise against trying a driving tour of the park after 2:30 p.m.



ANDREW J. RUSSELL, NATIONAL ARCHIVES

Fredericksburg, Virginia · December 1862 *&* *May* 1863

CASUALTIES 1862: U.S. 13,353 C.S. 4,576; 1863: 2,000*

*INCLUDES U.S. AND C.S.; SEPARATE FIGURES UNAVAILABLE

DRAPED WITH THE DEAD AND THEIR WEAPONS, a stone wall along a sunken road shielded Rebels as they decimated 15 Yankee brigades in December 1862 at the first battle of Fredericksburg. Five months later the Union reclaimed the ground. An 1863 image (left) provided details for restorers who rebuilt the wall stone by stone. The National Park Service is also adding new exhibits and marking original houses along the road, bolstering heritage tourism in the area.

LIBRARY OF CONGRESS, PRINTS AND PHOTOGRAPHIC DIVISION, CIVIL WAR PHOTOGRAPHS

Malvern Hill, Virginia · July 1862

CASUALTIES U.S. 3,000 C.S. 5,500

"Over five thousand dead and wounded men were on the ground . . . enough were

GUNPOWDER GRAY CLOUDS hover over Malvern Hill battleground, where roadside plaques tell of Yankee artillery destroying attacking Rebels. One cannonball beheaded 17-year-old Edwin Jemison (left), whose remains likely lie in an unmarked grave. Most soldiers killed in battle were hastily buried in mass graves; many were later moved to cemeteries. Some 620,000 men died in the Civil War—200,000 in battle, the rest from wounds and rampant disease.

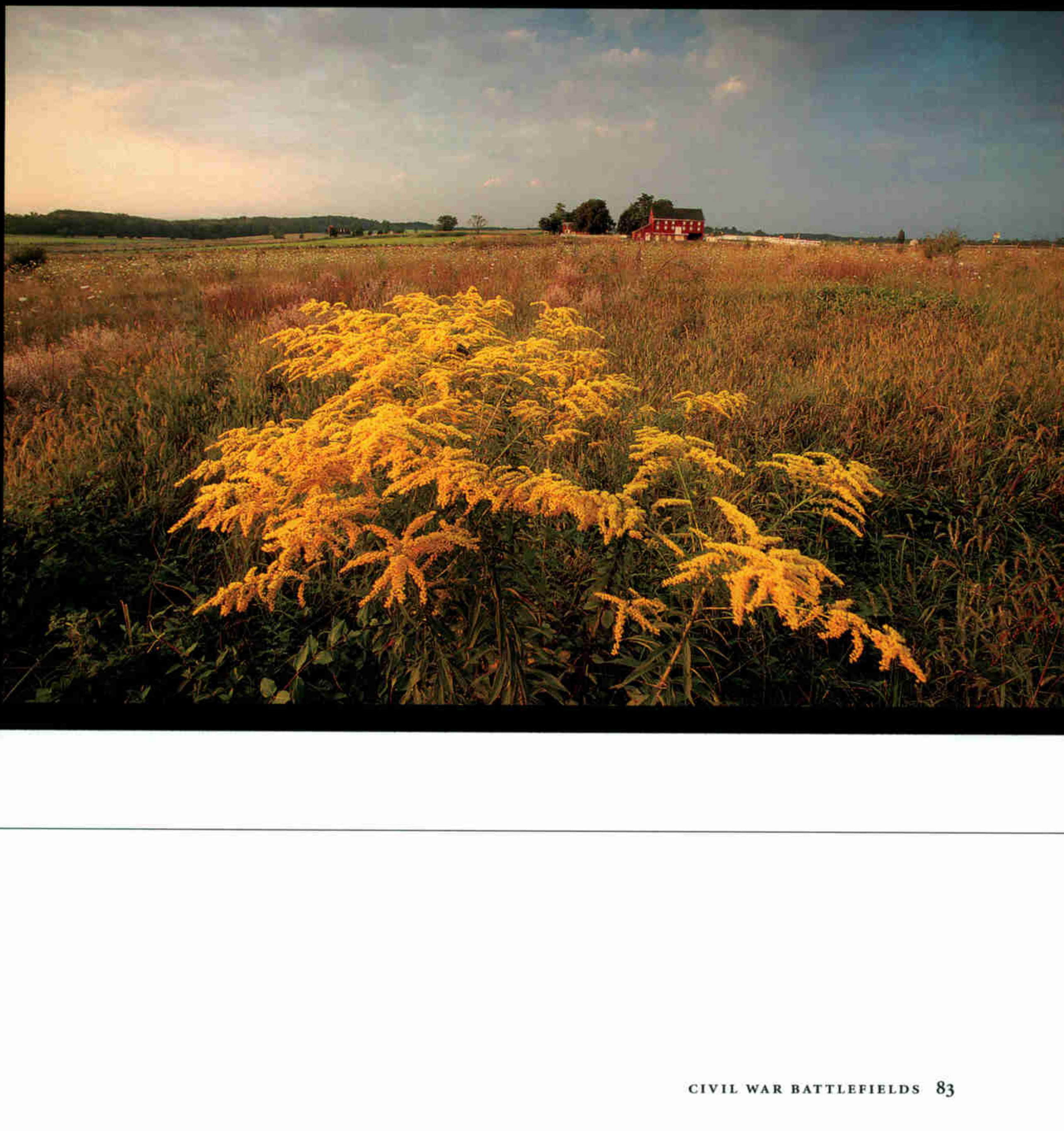
alive and moving to give to the field a singular crawling effect." —UNION GEN. WILLIAM W. AVERELL

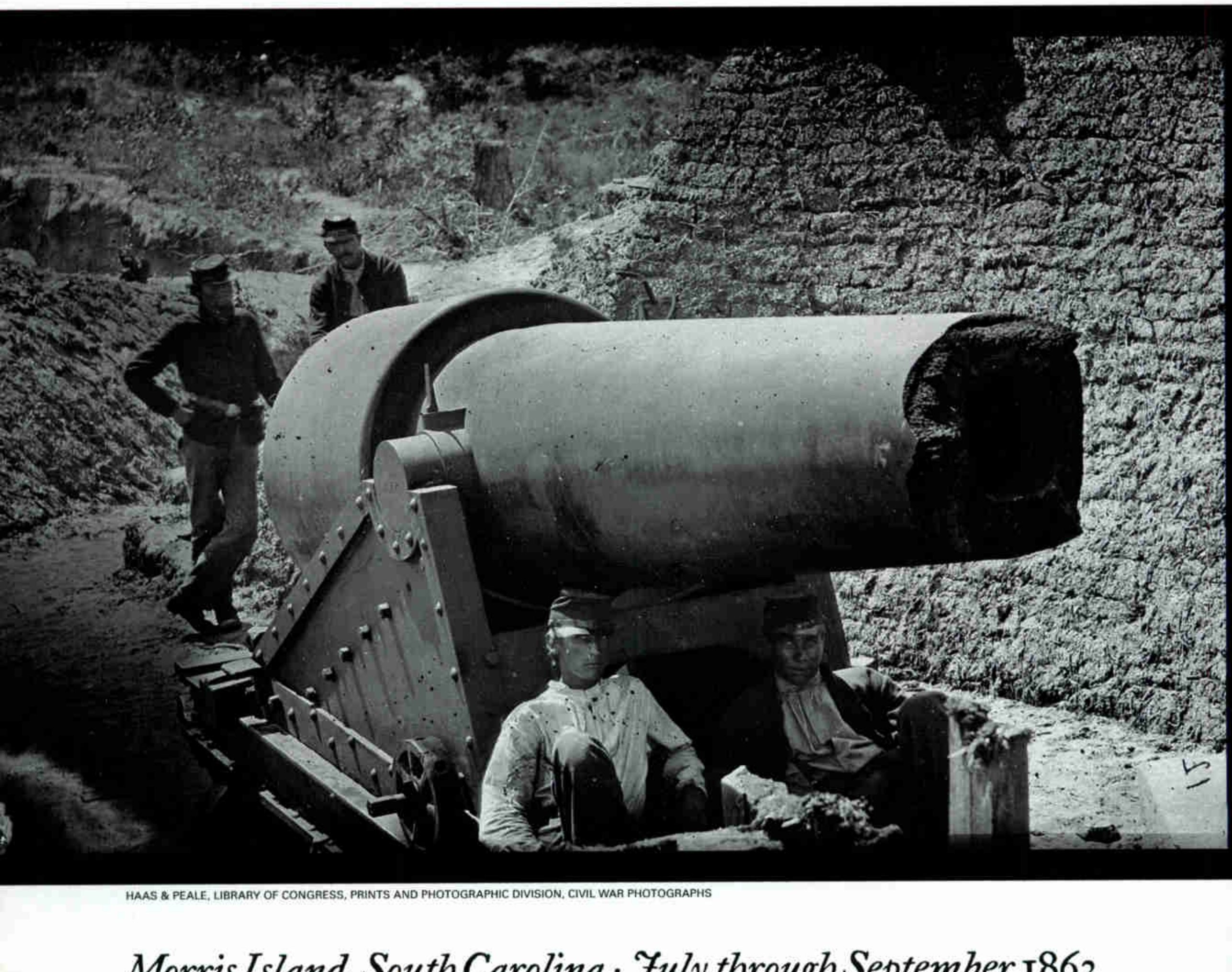
TIMOTHY H. O'SULLIVAN AND ALEXANDER GARDNER, LIBRARY OF CONGRESS, PRINTS AND PHOTOGRAPHIC DIVISION, CIVIL WAR PHOTOGRAPHS

Gettysburg, Pennsylvania · July 1863

CASUALTIES U.S. 23,000 C.S. 28,000

ON THE KILLING FIELDS OF GETTYSBURG, Union forces thwarted Gen. Robert E. Lee's push north. After three days of fighting, 40,000 men were killed or wounded, and more than 10,000 were captured or missing—the highest toll of any multiday battle in the war. Five months later President Abraham Lincoln came to dedicate a cemetery to the Union fallen (left) and give his now famous address. Some two million visitors still come each year to roam these fields and remember.



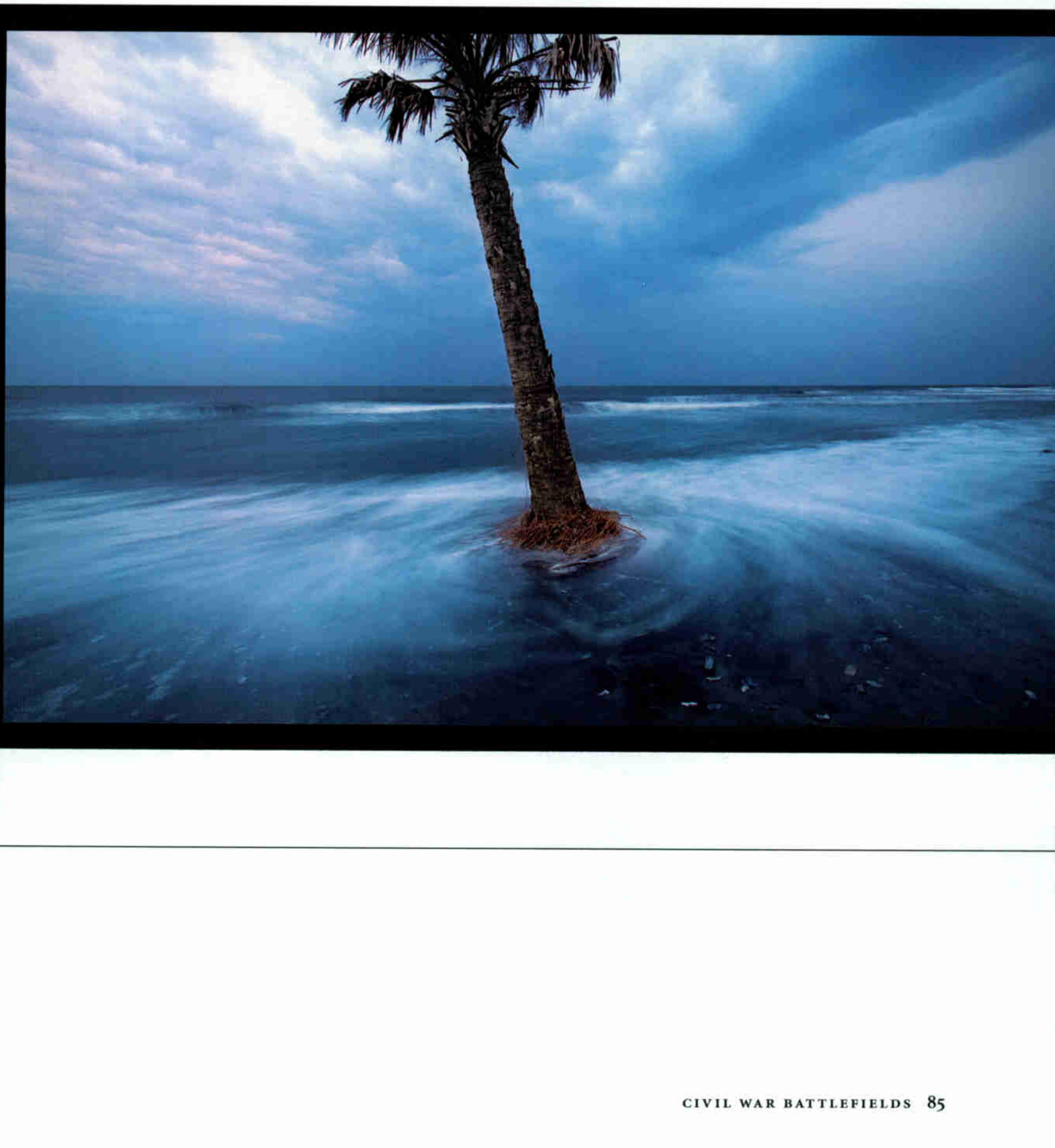


HAAS & PEALE, LIBRARY OF CONGRESS, PRINTS AND PHOTOGRAPHIC DIVISION, CIVIL WAR PHOTOGRAPHS

Morris Island, South Carolina · July through September 1863

CASUALTIES U.S. 1,515 C.S. 174

TARGETING FORT SUMTER IN CHARLESTON HARBOR, Union troops on Morris Island fired a 13-ton cannon until its barrel exploded (left). Nearby, black soldiers and white officers of the 54th Massachusetts Volunteers led a valiant but doomed assault on Fort Wagner. A lone palmetto stands near the battery site, now mostly eroded by wind and waves. Preservationists are rushing to protect Morris Island before development and time erase another Civil War touchstone. □

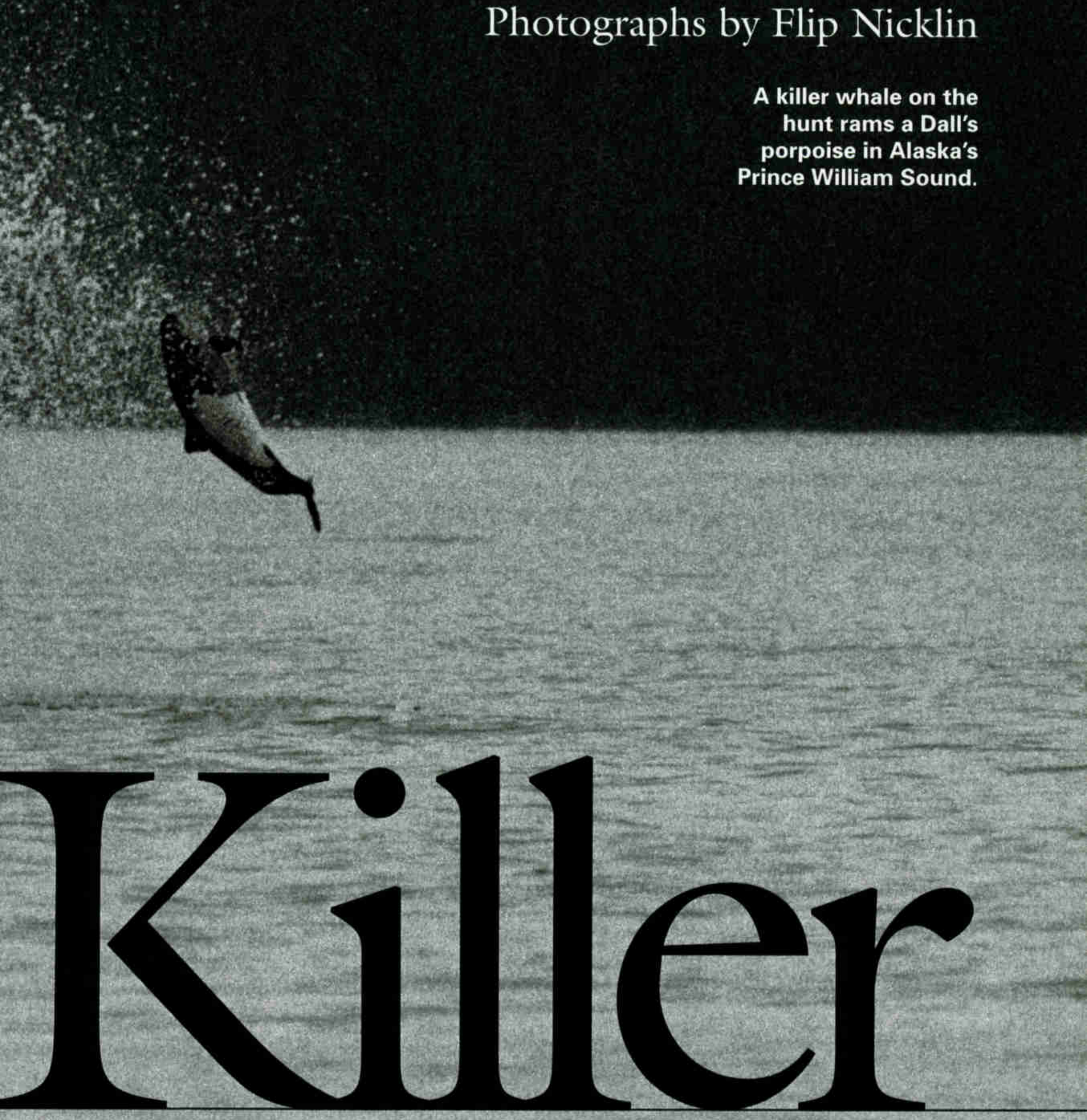


Investigating a

This killer's not black and white. A revealing profile of a predator shows a complex animal with multiple identities.

By Douglas H. Chadwick

Photographs by Flip Nicklin



A killer whale on the hunt rams a Dall's porpoise in Alaska's Prince William Sound.

EVA SAULITIS, NORTH GULF OCEANIC SOCIETY

Killer

Breaking the surface off Alaska's Aialik Cape, a family of orcas displays an easy kinship and a *smooth ride*, thanks to slick skin and streamlined shape. Water barely breaks over the crown of the juvenile at right.

Early June, Haro Strait, between San Juan Island, Washington, and southern Vancouver Island, British Columbia. Low swells from the southwest, scattered a.m. fog, turning to smooth seas and sunny skies by noon.

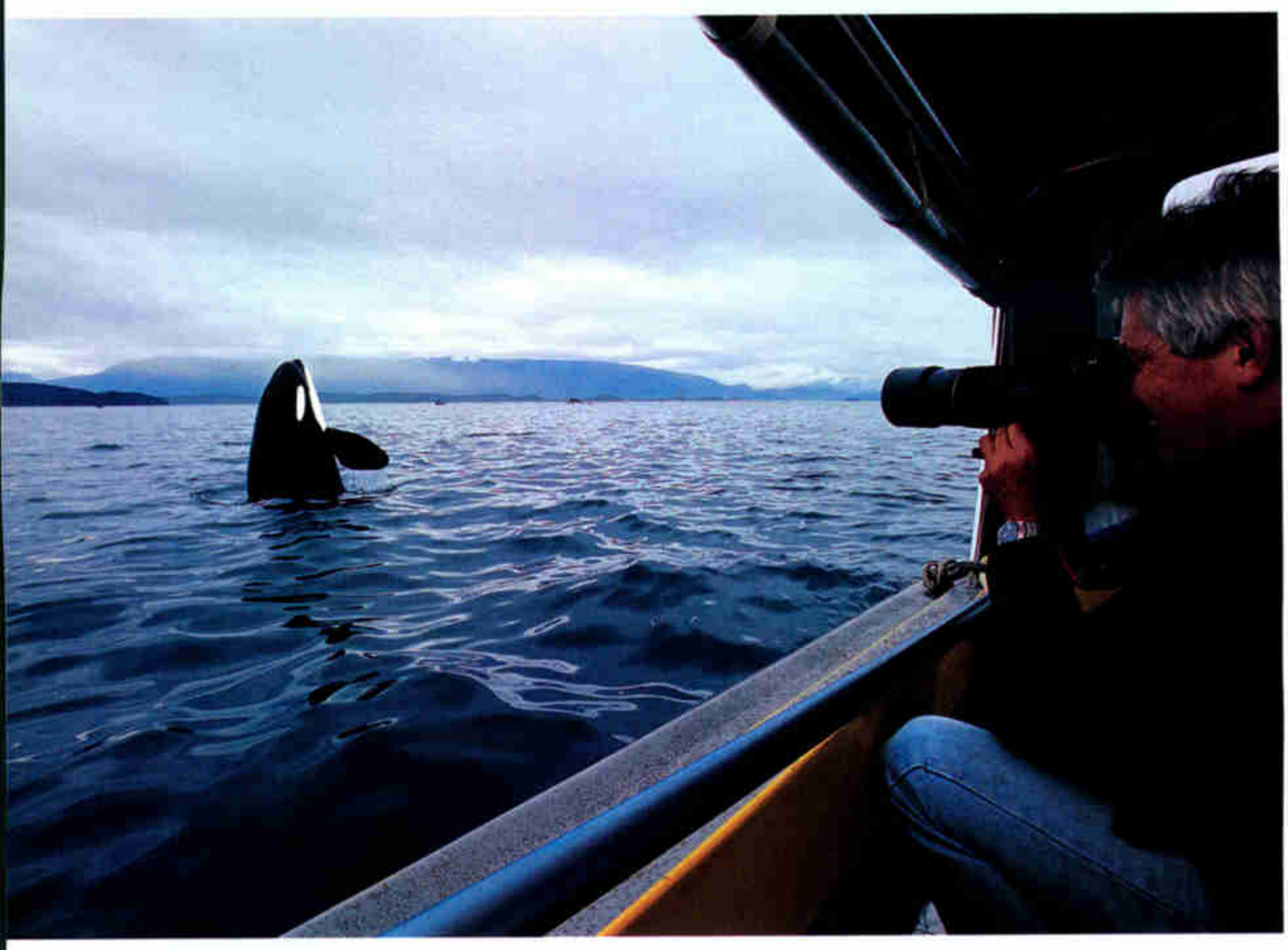
• • •

Today is the day the K and L pods of killer whales have chosen to return from their winter travels. After rushing out in a small boat to meet them, researcher Dave Ellifrit is taking inventory while snapping photos to verify identities. This is what it sounds like: "Ooh yeah, L88! (Snap.) L73 (snap) is looking good. L82! (Snap.) L55. (Snap. Snap.) Dammit, she ought to be having kids by now. Wait! And a calf! It's a new calf. And it's right by L55! SHE DID IT! L25, L21, L83, L86 . . . Ka-ching! Ka-ching! Hot *$%@#, man. We're racking 'em up. But no L3 yet. Since the rest of her family is here, she's probably dead. So I feel bad for L74. Lost his mom. (Snap.) There's L41, though. (Snap.) Whoo!"

During a pause in the action, we radio the captain of a nearby whale-watching boat about the new calf. Within minutes, the birth announcement is not only circulating through the commercial whale-watching fleet but is also washing ashore.

Ken Balcomb, head of the Center for Whale Research, where Ellifrit works on San Juan Island, is doing errands in town when shoppers and clerks come hurrying over to tell him the news.

Out on the water we've shut down the engine, waiting to see where the L's will reappear after a long dive. They end up surging by on either side. Farther away, one launches from the water. Ellifrit ID's it with a glance: "L53. She's often the first



Graeme Ellis of the Pacific Biological Station in Nanaimo, British Columbia, captures an orca on film for a photo identification census. This whale is "spy hopping," or surveying its surroundings. "Spy hopping is reasonably common," says Ellis, "and at times makes me ponder who is studying whom."

to start a surface display." On cue her companions begin breaching, doing side rolls, lobtailing (lifting their flukes high in the air and thwacking them down), and slapping the water with their paddle-shaped flippers or pectoral fins. "Psycho Whale—I sometimes call L53 that—is a very percussive animal," Ellifrit says. "I've seen her lobtail until the water turns to froth."

Early descriptions of "whale killers" or "killers of whales" gave rise to the common name killer whale. More in vogue is the name orca, from the species' scientific label, *Orcinus orca*, but for those who know Latin, "whale from the underworld of the dead" is hardly an image upgrade. Strictly speaking, orcas are not whales. They are the world's largest, brawniest dolphins, found in every ocean. With enormous reserves of speed and strength, one of the biggest brains in existence—four times the weight of a human's—and no natural enemies as adults, they have staked a claim as the supreme predators across 71 percent of the planet. What do they do when they meet a great white shark? Lunch, according to witnesses.

And how do they view us? Killer whales "will attack human beings at every opportunity," a 1973 U.S. Navy diving manual warned, reflecting a long-held belief. (An orca did grab a surfer once but quickly let him go—the only documented assault on humans in the wild, ever.) At the opposite end of the attitude spectrum, biologist Ingrid Visser jumps in with groups she studies on New Zealand's coast. Adult whales have swum over to show her sharks or rays, much as they would display food to juveniles in the pod. She says she knows of several lobster divers who were poking in crannies on the bottom when they felt a nudge and turned to find a huge, black-and-white creature looking on as if to say, "Whatcha got there, little fella?"

A clearer understanding of killer whales began with the simple fact that their dorsal fin—up to six feet tall in adult males and about half that height in adult females—clears the water each time they rise to breathe. In the early 1970s a visionary Canadian named Michael Bigg overcame skeptics to prove that these animals could be individually recognized by a fin's size, shape, and irregularities such as nicks or tears, plus the pattern of the light-colored saddle patch below the fin's trailing edge. With photo-ID catalogs in hand, a small cadre of researchers was soon charting births, deaths, and social changes in populations along North America's Pacific coast. Still under way, this investigation has become one of the great sustained efforts on the frontiers of science, practically an anthropological study of long-mysterious underwater tribes.

What researchers are finding is that there may be no tighter or longer lasting relationships among large animals than those that bind killer whale families. Researchers call these basic social units matrilines because they are led by the oldest female, or matriarch. A typical pod, as groups are called, consists of several generations in a single matriline or closely related matrilines traveling together. Scientists label the pods with a letter (or combination of letters) and use numbers to identify the various members. For example, a new calf that is the 15th animal recorded in B pod becomes B15. Pods with common ancestors and dialects are considered a clan, and clans that regularly associate and share the same range form a distinct population, known as a community. Within communities, aggression is virtually unknown, and different communities largely ignore each other on occasions when their travels overlap. That such powerful, predatory mammals have found ways to live together in seeming harmony never ceases to surprise us scrappy primates keeping watch.

Mid-June, western shore of San Juan Island, overlooking a cove beside Haro Strait. Partial clearing, low waves sequined by a sharp breeze.

• • •

While scanning the seascape from the porch of his home, Ken Balcomb says, "I first got hired by the National Marine Fisheries Service in 1976 just to count the killer whales in the area. I thought, hey, give us two or three years, and we can get all kinds of information about their biology. Talk about optimistic!"

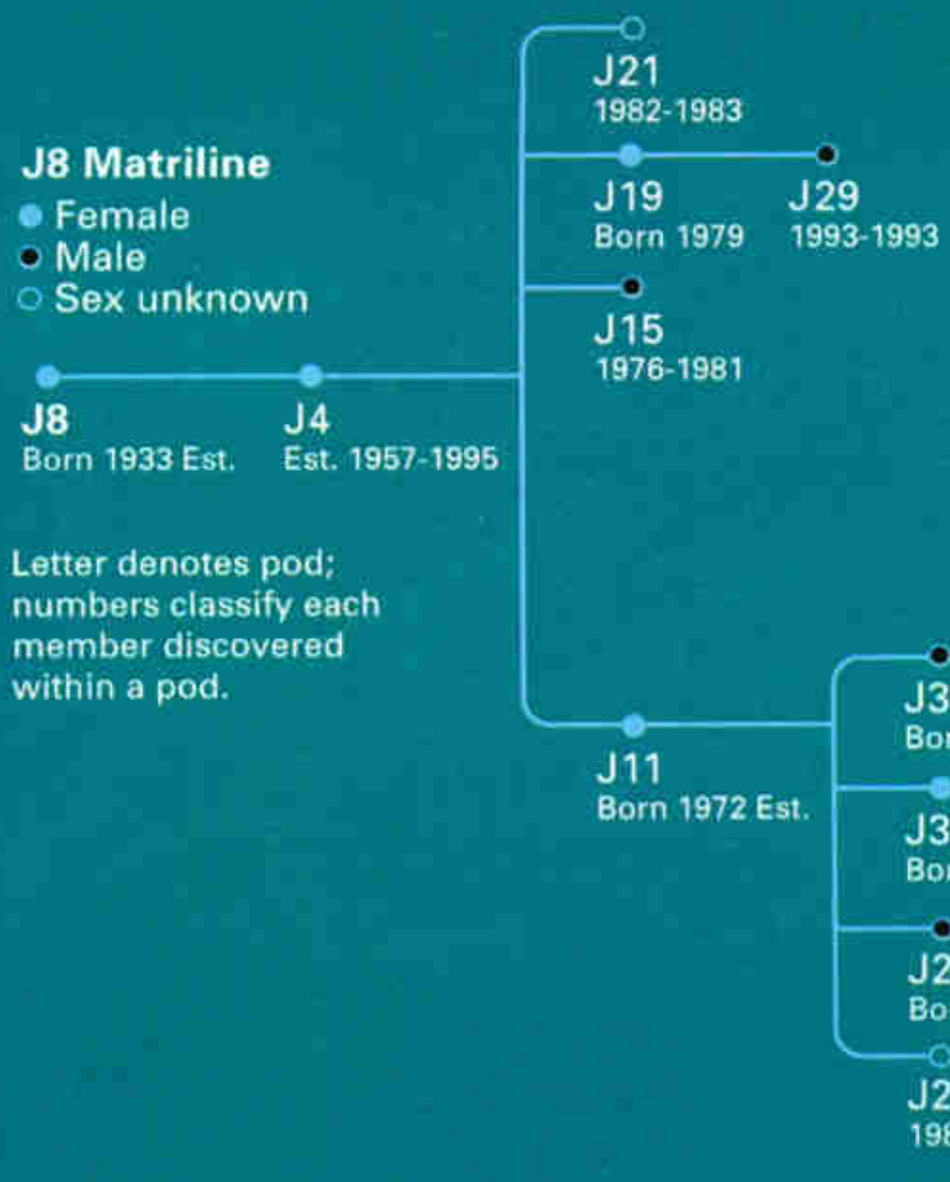
The pods his team studies—the J's, K's, and L's—make up the southern resident community off the Pacific coast. No one yet knows where they winter, although some have been glimpsed off Oregon and as far south as California's Monterey Bay. They were called residents because they always return to chase salmon in the waters of Puget Sound and southern Vancouver Island

Male

J8 Female

Residents

With rounded dorsal-fin tips and a preference only for fish, residents stick relatively close to the coast and make a racket with their complex calls.



Letter denotes pod; numbers classify each member discovered within a pod.

Transients

Pointy fins usually mark these silent stalkers that eat marine mammals. They roam, able to swim from southern Alaska to southern Vancouver Island in ten days.

Offshores

Individuals are smaller with curved fins and more nicks than other orcas. This group has yielded the least data because it stays out to sea.

the tribes of Orca

Orcas may be gentle or fierce, homebodies or rovers, fish-eaters or mammal hunters. Though killer whales live in every ocean, scientists know most about resident populations along North America's Pacific coast, some of which they've studied for three decades. Less is known about two other local orca types—transients and offshores—because of their less predictable ways. Each type is distinguished by dorsal fin shape, diet, and even language. The animals can live as long as humans, over 90 years, and have five or six offspring in a lifetime. A resident female named J8 (above) is known by her stubby fin and scarring on her saddle area. She heads one of several family trees, or matrilines, within the J pod. The septuagenarian J8 and her offspring have entertained generations of whale-watchers.

Resident Ranges

Ranges of residents stretch some 3,000 miles along the Pacific coast. Southern residents hug San Juan Island (inset) in summer and fan out daily into local straits to feed on runs of migrating salmon.

ART BY JOHN DAWSON
NATIONAL GEOGRAPHIC MAPS

To transient killer whales, sea lions are like sausages with whiskers. In an effort to escape the transients, dolphins sometimes hurl themselves up onto beach rocks in a suicidal frenzy.

from early summer through late fall. Within day-tripping distance of greater Seattle and the Canadian cities of Victoria and Vancouver, they may be the most popular, closely watched whales on the planet.

Loudspeakers on Balcomb's walls carry sounds picked up by a hydrophone he keeps permanently deployed off a rocky point to the north. Cocking an ear, he detects the calls of J pod long before we spot spouts. As they near, Balcomb points out the matriarch J2 and describes how he calculated backward from the known ages of her offspring to put her probable birth date at 1911, making her one of the oldest orcas ever recorded. He says, "Think of all the changes that whale has seen."

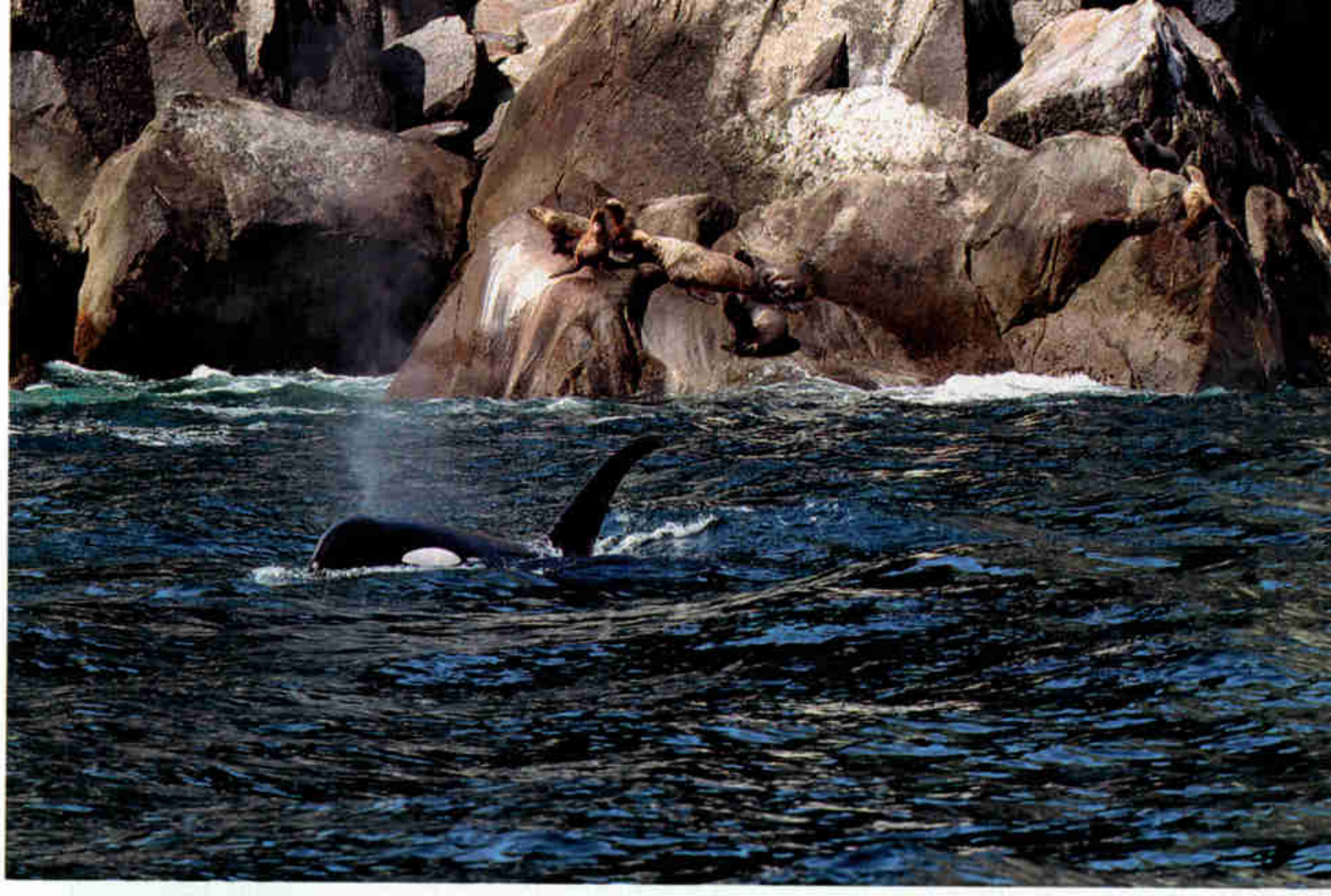
Year upon year, J2 swam past a spreading human populace that was certain her kind were man-eaters, fishermen who shot the whales on sight as competitors, and, starting in the 1960s, entrepreneurs who captured them live for aquariums and theme parks. Badly depleted before the roundups were phased out in the area in the mid-'70s, the J's, K's, and L's rebounded from 71 individuals in 1976 to 99 by 1995. They have since slipped by about 15 percent and are slated to be listed as threatened in the U.S. this year. Chinook, or king, salmon—these whales' favorite food—are listed as threatened in Puget Sound. The fish have been slammed by overharvesting, dams, and pollution, while the long-lived orcas themselves have accumulated worrisome loads of PCBs and dioxins from their prey. These pollutants disrupt mammals' reproductive, immune, endocrine, and neurological systems. Peter Ross, of Canada's Institute of Ocean Sciences in Sidney, British Columbia, says killer whales are the most PCB-contaminated mammals yet recorded. He and others are also alarmed by contamination levels from chemicals in flame retardants used in everything from clothing to computers.

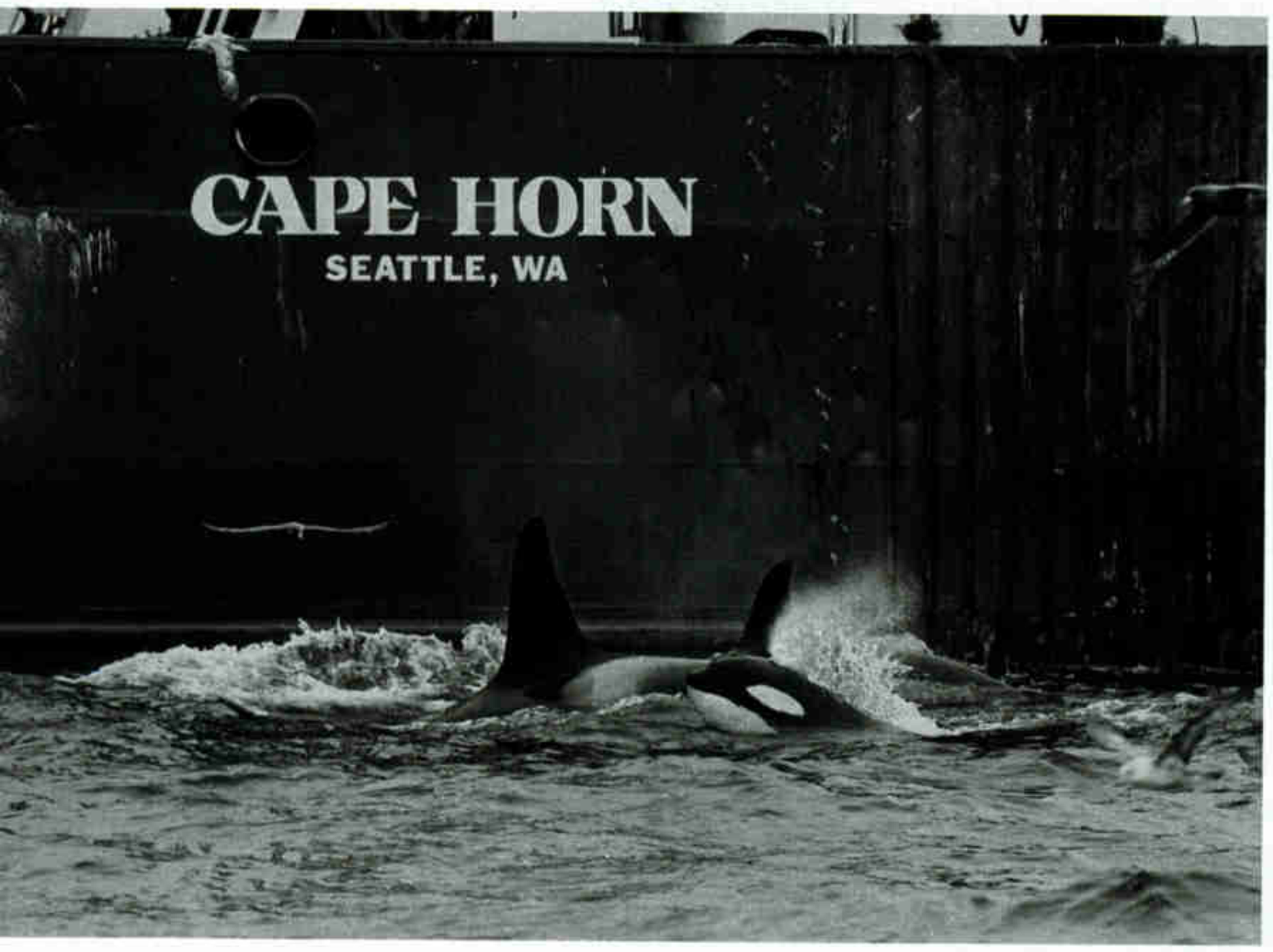
Another transformation took place during J2's arc of years: Those captives performing in concrete pools revealed themselves to be not monsters but clever, sociable giants. Artists were inspired to make the animals icons of the Pacific Northwest, as they were in Indian times, and crowds were suddenly eager to visit pods in the wild. Add enough whale-watching vessels and curious private boaters on top of shipping traffic, and you get a modern controversy over whether it is possible to love killer whales a little too much, since the noise of boat engines may interfere with the whales' communication. As J2 and her relatives swim out of view, Balcomb's voice rises over the underwater noise pollution from thrumming, whining engines picked up by the hydrophone. "Think," he is saying, "of all the changes she has *heard*."

Killer whales depend far more upon hearing than sight. The sounds they make while hunting are high-frequency pulses generated in the nasal passages, then focused by a fatty lens in the forehead. To us this organic sonar technology just sounds like a series of loud clicks. For the whales it is a way to navigate the submarine terrain and expose prey through precise echolocation. The animals also have an array of plaintive calls, which they rely upon to make contact and convey information over longer distances. But during play, "It all turns to loony tunes," says John Ford, chief whale scientist for the Pacific region of Canada's Department of Fisheries and Oceans, "burbles, squeals, whistles, raspberries, and snorks."

As a graduate student during the 1970s, Ford noticed that every pod has its own version of the calls in terms of pitch, pattern, and the number used. Each dialect is an acoustic badge of identity; youngsters learn their pod's dialect from their mothers and older siblings. They also learn to recognize the dialects of other pods. Since killer whales want to fraternize with their nearest kin but must pick mates from among the most distantly related pods within the community in order to avoid inbreeding, they need an

DAVID ELLIFRIT, NORTH GULF OCEANIC SOCIETY (CENTER); DAVID ELLIFRIT, CENTER FOR WHALE RESEARCH (BOTTOM)





Transient orcas attack a minke whale near Vancouver Island (below), ramming it before drowning it by holding it underwater. A resident orca forages for salmon in Alaska's Resurrection Bay (above) under the watch of Steller sea lions, which can likely distinguish the calls of fish-eating orcas from those of mammal-eaters. A resident mother and offspring (left) gorge on fish discarded from a trawler in Alaska's Aleutian Islands.

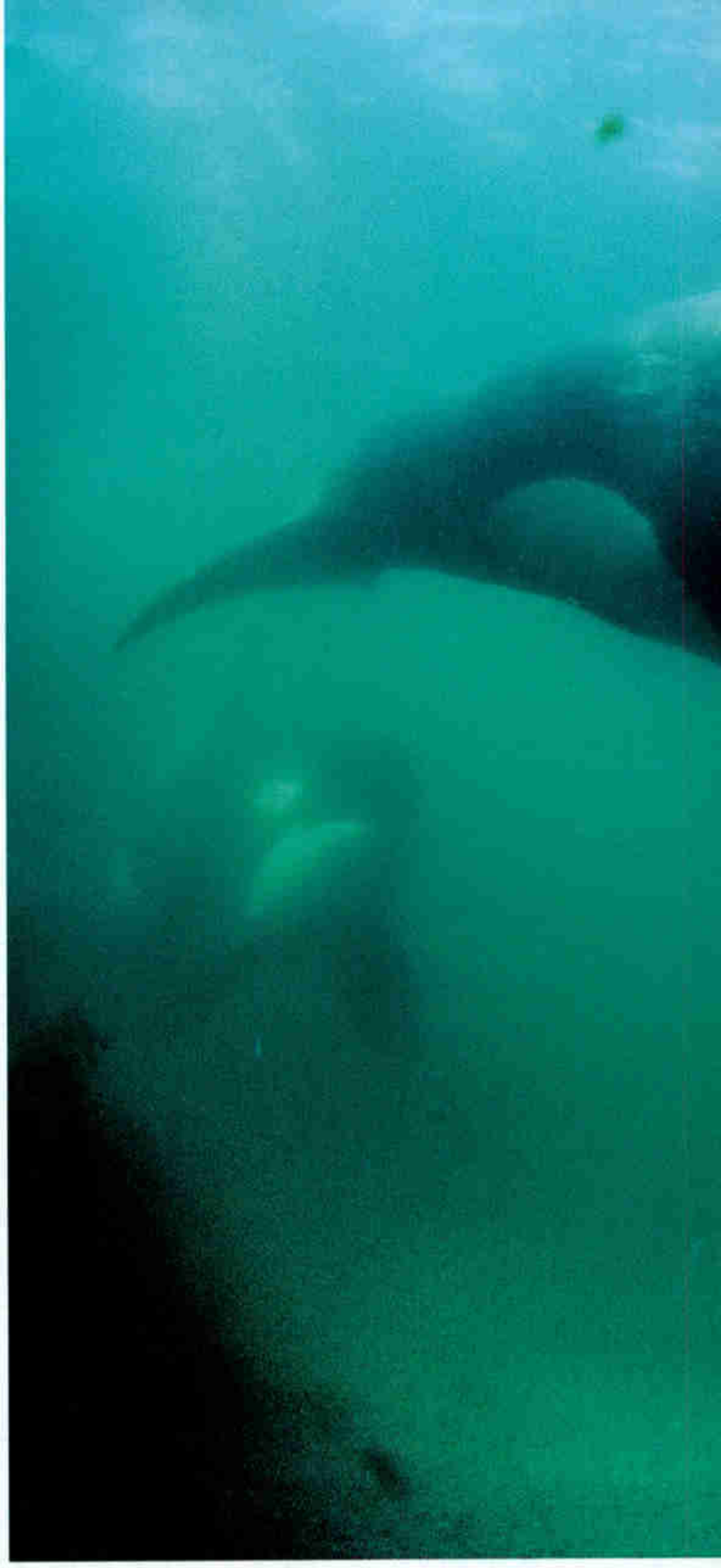
Orcas rub across small, smooth pebbles near the beaches of Vancouver Island. Clearly a pleasurable activity, beach rubbing occurs only in certain resident groups here, leading researchers to consider it a "cultural" tradition.

easy way to tell which is which in the often dim waters they ply. The calls do the job, since the more similar a dialect is from one pod to the next, the closer their bloodlines.

Mating outside the community doesn't seem to be an option, mainly for cultural reasons. Different populations don't even speak the same language or practice the same traditions. For example, Johnstone Strait, separating northern Vancouver Island from the mainland, is the core summer range for about 200 whales in 16 pods known as the northern resident community. One of their favorite activities is rubbing on certain pebbly beaches in shallow water. Whether such sites are for removing itchy skin and parasites or recreational centers where pods go to mingle is open to discussion. Either way, the southern residents living practically next door never rub. On the other hand, they are much more likely than northern residents to erupt in the showy aerial displays that Balcomb calls fireworks.

Isolated behaviorally as well as genetically, each community appears destined to rise or fall on its own. That's why the drop in southern residents, and a smaller slip in northern residents, has folks on edge.

A third resident community ranges from the northern border of British Columbia across the Gulf of Alaska to Kodiak Island. A fourth continues farther west along the Aleutian Islands and on to the southern Bering Sea. Totaling perhaps a thousand, the whales seem to be stable or increasing in these northerly regions, where salmon stocks remain strong.



Third week of August, northeast of Port Hardy, Vancouver Island. Clear skies, unlimited visibility, light winds with a seaweed smell.

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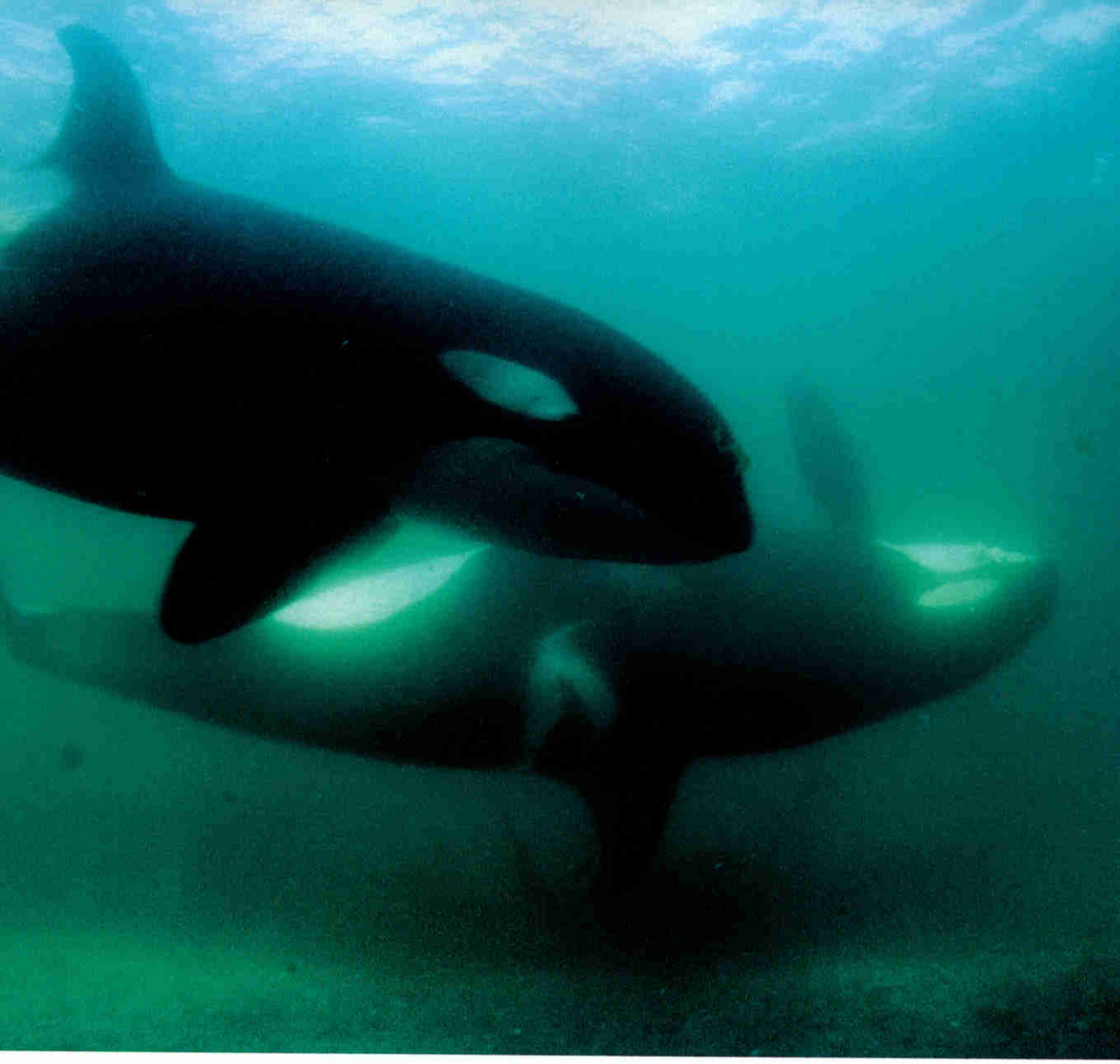
Rhinoceros auklets are diving for herring in tidal rip currents at the entrance to a channel. Beyond lie several small islands, and the water in their lee is like cellophane. Six fins jut from it, slightly more upright and sharply tipped than those usually seen here in the Johnstone Strait area. The tallest has a distinctive notch near the top. Flipping through a photo catalog, Volker Deecke, an Austrian researcher from the University of British Columbia, identifies this male as T142. It and two companions must be the T143 family, named after the oldest female. The other three, Deecke says, look like the T18's.

The most familiar pods along the coast, the residents, generally live in groups of from 10 to 40 and follow regular travel patterns within a seasonal range. They make calls about half the time they are submerged and broadcast sonar bursts freely to pick out food. At the surface they



are noisy and conspicuous, often floating like logs while they rest or making some big splash on the social scene. Their diet is salmon and more salmon, with the occasional lingcod, flounder, or other flavor of fish thrown in.

But back when orcas were being nabbed for display, one newly captured group of killer whales refused every fish offered for 78 days, even after a member died of starvation. Not until the 1980s did scientists fully realize that those animals represented another kind of killer whale.

For years observers in the wild had noticed small gangs of two to six killer whales that moved more randomly across a far greater area than residents typically did. What no one suspected yet was that these animals' meals would turn out to be exclusively warm-blooded: seals, sea lions, sea otters, dolphins, porpoises, and whales. They swallow a few seabirds and sometimes help themselves to a swimming moose or deer. But fish? No way. They also make longer dives, probe more closely along the shorelines, and call less than 5 percent of the time. To orient themselves, they send out sonar clicks in brief patterns that blend in with noises like stones knocking together in the surf. Otherwise, they run silent, listening—stalking. Scientists continued to label resident pods alphabetically but reserved the letter T for these smaller, less predictable groups. T stands for transients, the hunters of mammals.

Compared with residents, transient killer

FLIP NICKLIN, MINDEN PICTURES

Fins and frolicking can give indications about orca well-being. Dorsal fins of orcas under stress may flop over, like that of an Alaska male (above), which is thought to have endured a difficult winter in ill health. While most orcas, such as those passing whale-watchers near Vancouver (right), are indifferent to humans, calves often seem to show off. A juvenile named Auriga (below) breaches playfully near Seward, Alaska.

Eating the eaters of fish, transient killer whales are doubly loaded with PCBs. Some are so tainted with toxic brews they exceed the limits for the disposal of hazardous waste at sea.

whales have stouter jaws, perhaps to deal with larger, tougher prey, whose defensive abilities may also explain transients' more tattered-looking dorsal fins. (Eating the eaters of fish, they are loaded with twice the amount of PCBs found in residents. In the grandest of ironies, some transients are so tainted with toxic brews they exceed the limits for the disposal of hazardous waste at sea.) The saddle patch of transients sits farther forward than on residents. Nor do the two types share any of the calls in their repertoires.

The adult males in resident pods, once assumed to be harem bulls, are more like big momma's boys that never leave their family. While transient males also remain at their mothers' sides past maturity, researchers are finding that some strike out on their own beginning around age 20, and other family members may split off to travel apart or with another transient group for a while. After analyzing the DNA in skin samples, Lance Barrett-Lennard of the Vancouver Aquarium concluded that residents and transients have probably not interbred for at least 10,000 years. They may qualify as distinct subspecies and possibly separate species.

It seems other marine mammals clearly recognize the difference. When Deecke played killer whale voices to harbor seals, they fled at once from the transients' calls while ignoring those of local residents. Pacific white-sided dolphins and Dall's porpoises will zip around resident pods, riding their bow waves, swimming with them side by side. Sea lions even nip residents, possibly to contest good fishing spots. But to transients, sea lions are like sausages with whiskers. Dolphins are known to hurl themselves up onto beach rocks in a suicidal frenzy to escape the mammal-hunting orcas. Like wolf packs, the transients coordinate attacks, heading off a speedier swimmer by converging from different directions or chasing the target in relays until it tires.

At the moment, the T143's and T18's are moving in typical stealthy style, cruising near rocky isles and poking into crannies, surfacing only briefly in-between. All at once, by Duncan Island, they boil into plain view, breaching, rolling over each other like plump braids of rope, whapping flippers on the water, and generally frolicking like a resident pod. The time is 2:45 p.m. Deecke mutters, "Transients don't usually socialize like this except after a kill. How the heck did we manage to miss it?"

Later, we rendezvous in mid-channel with Graeme Ellis, a Canadian orca expert, tie our boats together, and share a snack while we drift. Ellis has the most experienced eyes in the business. And unlike us, he did witness a kill today. Some whales in the T59 group nailed a Dall's porpoise, he says.

Where? "About 17 miles south of where your group was cavorting."

When? Ellis checks his notebook: "Looks like 2:45."

The meaning hits like a breaking wave: As Ellis's group made its kill, their calls, traveling five times faster in water than in air, were funneled along submarine canyons and picked up by the animals Deecke was watching, stimulating them to start festivities of their own.

Discovering that such excitement can be contagious for transient killer whales over long distances has put Deecke, the sound specialist, in a mood to frolic too. Throwing his arms wide, he proclaims to passing gulls, "Behold the power of acoustics!"

Earlier in July on Vancouver Island's eastern coast.
Slack tide, smooth water, muffling mist.
Visibility less than a quarter mile.

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Here's Graeme Ellis, fogbound, edging his boat from Telegraph Cove out into Johnstone Strait,

Whale bait: Orcas in New Zealand's Bay of Islands pursue a mako shark, which they eventually killed and ate—the first record of orcas preying on a mako. Sharks and rays form a key food source for New Zealand's orcas but contain hazardous heavy metals and chemicals that could harm them.

INGRID N. VISSER,
ORCA RESEARCH TRUST

reflecting on how our understanding of orcas has shifted around like a sandbar: "I've been coming out here 30 years, and I'm still working with some of the same whales. Old friends, you know? So little was known about them at first that we kept looking for comparisons. Are they like lions? Canines? Hoofed animals? None fit. They're like killer whales. But then we find different types. Maybe the best analogy is: They're like humans. Different tribes, different dialects—different cultures, if you like."

From time to time, as many as 60 killer whales traveling in a swarm appear near the continent's Pacific coast. The animals are smaller than either residents or transients, their dorsal fins are more often ripped and nicked, and they seldom stick around long. By the 1990s Ellis and others finally felt certain that these constituted a third major type of killer whale in the region. The researchers labeled them offshores, on the theory that they spend most of their time well out at sea. Little else is known about their lifestyle. Since offshores are very vocal, they probably don't dine on mammals. Whatever they do eat seems to wear down their teeth. Guesses include sharks, which are taken by killer whales elsewhere.

The orcas off North America's Pacific coast may be the world's best studied, but it remains to be seen whether they can serve as models for the species elsewhere. The harder scientists look, the more killer whales they turn up with different physical traits, travel patterns, social groupings, call patterns, and learned traditions. The division between fish-eaters and mammal-hunters generally holds up for killer whales around Antarctica and Norway. But those that prowl the subantarctic Crozet Islands for southern elephant seal pups apparently turn to fish after the rookeries empty. Though data from much of the world is spotty, it appears that some populations make their meals mostly of tuna. Others include squid. Still others live up to the old name of whale killers. Contrary to the popular vision of pods tearing apart victims with

In Alaska, young Auriga surfaces next to the photographer's boat. Some calves are shy and stay close to their mothers. Others, like Auriga, are more independent. "One factor may be that his mother, Tutka, is very boat friendly," says Eva Saulitis, an Alaska-based orca expert. "A whale expresses its personality to humans only in rare instances, like snapshots. Auriga exemplifies the fact that killer whales have distinct personalities."

Once assumed to be harem bulls, the adult males in resident pods are more like big momma's boys that never leave their family.

their teeth, shark style, they are more likely to wait for a safe opening, then ram the victim with their heads or bludgeon it with their flukes. Like other predators, they tend to target the weakest, most vulnerable members of a prey population. These are often the young, as in the case of West Coast transient pods seen attacking gray whales as they migrate north each spring with newly born calves.

Early July, Holkham Bay, about halfway between Juneau and Petersburg, Alaska. Glittering sunlight on light chop, waves building higher out in Stephens Passage.

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For days, Volker Deecke—buzz cut, hatless, and wearing the same grease-stained, red flotation jacket and salt-stained, black windbreaker pants—has been motoring up and down Tracy Arm and Endicott Arm in an inflatable skiff, dodging icebergs calved off tidewater glaciers at the head of these fjords. Mother seals gather on the floes by the hundreds to give birth. Some are starting to leave for more open waters with their newly weaned, month-old pups—pudgy, inexperienced, snack-size morsels. Deecke knows transients will come scouting.

Back aboard the fishing boat that serves as our mother ship, Deecke wanders the deck doing what scientists do in their slack time: ponder. "To appreciate other people's cultures," he says, "you have to shed your prejudices—strip yourself down to where you are just human and then build up your understanding. With killer whales, I feel we are moving one step beyond. You must strip all the way down to just being a mammal, then start from scratch trying to understand how the whales perceive and interpret their world. Imagine 'clicking' [focusing a sonar beam] on another member of your society."

We can barely see six feet into this water clouded by glacial silt. But with sonar clicks, a killer whale can monitor family members hundreds of yards away. At closer quarters one animal may be able to tell whether another's stomach is full, if it is pregnant, and from the thickness of blubber, its overall condition. Think full-body sonogram. The whales may also pick up information merely by listening quietly for heartbeats and stomach rumbles from companions or for distant splashes and breathing sounds from prey.

Toward midmorning half a dozen orcas glide past on their way out of Endicott toward the point called Wood Spit. Tight formation, sharp-tipped fins: transients. We weigh anchor and follow. As a male approaches the shallows, he lifts his head for a better view. A harbor seal on a boulder surrounded by waves does the opposite, laying its head flat against the stone and holding very still. Any seals still in the water have likely squeezed into hiding spots among the rocks and kelp. The transients round the point and cruise on toward Stephens Passage. After their next dive, only the male reappears, still headed away. The minutes stretch on. We are scanning the horizon for the others when they surface almost on the beach. Having made what looked like a feint toward open water, the whales executed a right-angle turn in the depths and swam a quarter mile submerged back to Wood Spit.

"They're milling!" Deecke cries and lowers his hydrophone. "I've got calls. And little squeals and mews." Social noises—more signs of a probable kill. Five minutes later the whales move off. All that's left is an oily sheen on the surface and gulls squabbling over shreds of blubber and meat. The lack of drama is a tribute to the predators' efficiency—plus the fact that female killer whales weigh as much as six tons and males nine or ten, while a harbor seal averages about 250 pounds. If transients are the proverbial wolves of the sea, this is a pack snatching a rabbit, not hauling down an elk. Swish, swish—wham! And one of those seal's heads that followed me whenever I kayaked along Wood Spit in the evenings is no more.

Third week of August, Knight Pass, western Prince William Sound, Alaska. Variable clouds, light chop, turning heavier with afternoon winds.

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Craig Matkin, director of the North Gulf Oceanic Society, and colleague Eva Saulitis are running his 34-foot boat, the *Natoa,* parallel with the resident group known as the AE pod, but the whales keep fanning out after silver, or coho,

Dozing orcas in Prince William Sound hint at the social ties that help them learn, eat, and survive. "I had never seen anything like this," says Craig Matkin, a killer whale expert, of the almost 80 animals at rest here. "These whales do and must stick together."

salmon. Only AE11, born in 1970, and her calf, AE23, born in 2000, stay close enough for identification photos. In fact they're coming straight for the boat.

Although a number of older killer whales still carry scars from fishermen's bullets, relations between our species and theirs have improved to the point that orcas from many formerly shy pods no longer avoid boats. Some individuals will come over to swim alongside awhile. In recent years two different young orcas—one from the southern resident community and one from the northern—apparently desperate for company, took to playing with boats and allowing people to pet them. But the mother and calf heading for our boat aren't paying a social visit. They are after a coho that just sought refuge under the *Natoa*.

AE11 comes within inches of scraping the hull as she races the fish from bow to stern. Overshooting her target when it jukes to one side, she doubles back in a massive swirl and circles several times while the salmon makes frantic turns inside the orca's orbit. She is not trying her hardest to catch it. Rather, she is herding the fish until her calf joins the hunt. As the salmon tries to break away by diving, she goes deeper, driving it near the surface again. And in between, young AE23 is six, five, four . . . three feet behind the coho's tail. Ten minutes and multiple spins, rolls, submarine somersaults, and close calls later, we are still scrambling around the deck cheering, mostly for the young whale but with growing respect for this badly vexed fish. At last the lesson, or practice session, is over, the calf swimming off with the salmon in its jaws.

Like humans, killer whales are a blend of what they are born to be and what they are taught. The young nurse for as long as three years. Before the flow of milk stops, a mother needs to make sure her offspring is skilled at catching food for itself. Ingrid Visser, the New Zealand biologist, thinks juvenile orcas overcome a natural reluctance to enter dangerously shallow bays, where rays flourish, by emulating older animals. Youngsters in other pods learn to take sharks caught on the hooks of fishermen's longlines—again, Visser reports, by observing their elders. Much as transients will drive dolphins into a bay and then form a line to cut off escape, resident-type killer whales in Norway work together to herd herring against the shore. In another coordinated effort, called carousel feeding, a pod may encircle a herring school in open water, forcing the fish into a defensive ball. The whales then take turns lashing at the huddle with their flukes, stunning mouthful after mouthful. Some Antarctic killer whales will speed in a curve toward ice floes, setting up waves that wash seals off the slick surface into the water.

June, morning in Agnes Cove,
on Alaska's Kenai Peninsula.
Dimpled by a drizzle, the bay is glassy,
with fog streaks drifting through.

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The sounds of big breaths announce whales fishing their way into the bay's quiet embrace. It's the AD5's again, a friendly resident pod. As usual the group members spread out to hunt, diving at intervals while they sweep along at a steady four or five miles an hour.

I paddle my kayak to a better vantage point, but not too close. That's good, because a couple of adults suddenly shoot ahead after their quarry. Going airborne at times, they accelerate to 20 miles an hour as if turbo-thruster engines had just kicked in. Dorsal fins slice the water trailing rooster tails of spray. After the almost casual pace at which these mega-dolphins usually go about catching prey, here is a reminder that *Orcinus orca* can punch out great white sharks. I too come from an impressive culture that meshes power with knowledge transmitted between generations. But scrunched down in my little eight-foot-long tub while a male almost four times as long comes steaming past with its salmon catch, I wouldn't begin to argue over who the true master of the oceans might be. □

KILLERS IN BLACK AND WHITE Go online to see more of these brilliant beasts in action and download your own killer wallpaper at **nationalgeographic.com/magazine/0504**.

CRAIG MATKIN, NORTH GULF OCEANIC SOCIETY

LIFE AND DEATH AT THE DAWN

ABYDOS

OF EGYPTIAN CIVILIZATION

Portals to the great beyond, 5,000-year-old graves
at Abydos reveal startling clues to an archaeological mystery:
Did Egypt's earliest kings practice human sacrifice?

BY JOHN GALVIN
PHOTOGRAPHS BY KENNETH GARRETT

KING AHA, "THE FIGHTER," was not killed while unifying the Nile's two warring kingdoms, nor while building the capital of Memphis. No, one legend has it that the first ruler of a united Egypt was killed in a hunting accident after a reign of 62 years, unceremoniously trampled to death by a rampaging hippopotamus. News of his demise brought a separate, special terror to his staff. For many, the honor of serving the king in life would lead to the more dubious distinction of serving the king in death.

On the day of Aha's burial a solemn procession made its way through the sacred precincts of Abydos, royal necropolis of Egypt's first kings.

KENNETH GARRETT, EGYPTIAN MUSEUM, CAIRO (LEFT)

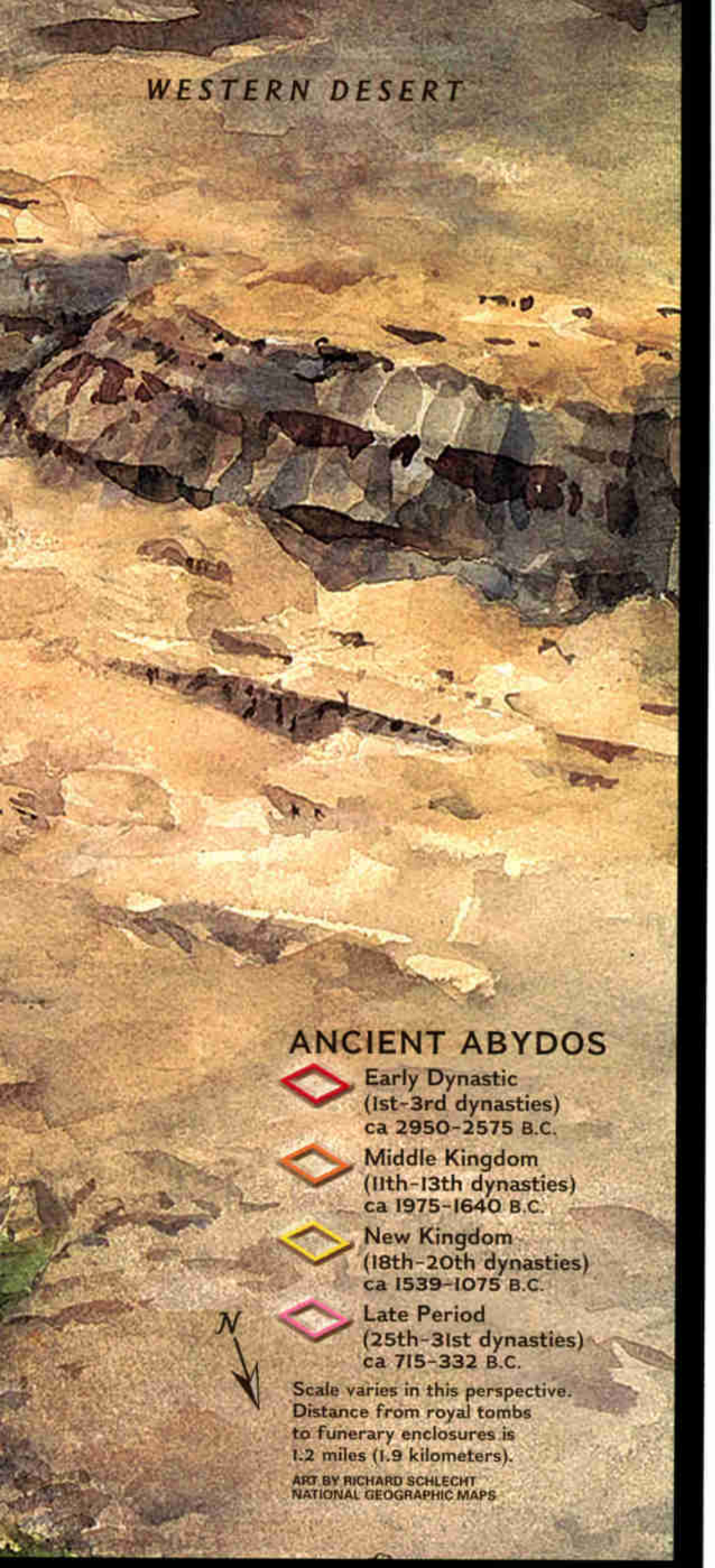
Swept clean of sand, mud bricks preserve the outline of a grand tomb once roofed with wood. When 2nd-dynasty king Peribsen was buried here around 2700 B.C., Abydos was already ancient. Archaeologists have found the stela of a 1st-dynasty queen (bottom left), as well as tags made of bone from about 3200 B.C. bearing some of the earliest writing known.

Led by priests in flowing white gowns, the funeral retinue included the royal family, vizier, treasurer, administrators, trade and tax officers, and Aha's successor, Djer. Just beyond the town's gates the procession stopped at a monumental structure with imposing brick walls surrounding an open plaza. Inside the walls the priests waded through a cloud of incense to a small chapel, where they performed cryptic rites to seal Aha's immortality.

Outside, situated around the enclosure's walls,

ROYAL GRAVES, SACRED GROUND

During the early dynasties, every king planning to be buried at Abydos erected a ceremonial enclosure near the Nile's fertile floodplain (above) and a tomb to the west—the realm of the dead—after ritually destroying the enclosure of his predecessor. The body of a modern jackal found in the ruins of an enclosure (right) evokes the early jackal god of the necropolis. In time that deity merged with the god of the dead, Osiris. People began to believe Osiris was interred at Abydos, which then became a pilgrimage site where kings built temples and cenotaphs through the centuries.



were six open graves. In a final act of devotion, or coercion, six people were poisoned and buried along with wine and food to take into the afterlife. One was a child of just four or five, perhaps the king's beloved son or daughter, who was expensively furnished with ivory bracelets and tiny lapis beads.

The procession then walked westward into the setting sun, crossing sand dunes and moving up a dry riverbed to a remote cemetery at the base of a high desert plateau. Here Aha's three-chambered tomb was stockpiled with provisions for a lavish life in eternity. There were large cuts of ox meat, freshly killed waterbirds, loaves of bread, cheese, dried figs, jars of beer, and dozens of wine vessels, each bearing Aha's official seal. Beside his tomb more than 30 graves were laid out in three neat rows. As the ceremony climaxed, several lions were slain and placed in a separate burial pit. As Aha's body was lowered into a brick-lined burial chamber, a select group of loyal courtiers and servants also took poison and joined their king in the next world.

Is this how a pharaoh's funeral in 2900 B.C. actually unfolded? It's a plausible scenario, experts say. Archaeologists have been sifting through the dry sands of Abydos for more than a century. Now they have found compelling evidence that ancient Egyptians indeed engaged in human sacrifice, shedding new—and not always welcome—light on one of the ancient world's great civilizations.

"YELLAH! YELLAH! YELLAH!" barks Ibrahim Mohammed Ali, the Egyptian crew boss, spurring his workers to move it, move it, move it. "You are big fat water buffalo! You are dung!" The mostly teenage boys hauling buckets of sand giggle nervously but pick up the pace while keeping an eye on their still ranting foreman. "You chatter worse than a bunch of women!" Standing tall in a loose, flowing galabia and white head wrap, Ibrahim looks somehow wizardly, maybe capable of vaporizing slackers with a cast from the long, intimidating stick-wand he keeps clutched behind his back. Ibrahim's 125-person

Sacrificed for her king, an elite woman in a wood coffin comes to light next to a royal enclosure. Five other courtiers lie nearby. After weeks of searching for the king's identity, archaeologists found his name on wine stoppers and part of a jar (right): Aha, first ruler of the 1st dynasty.

crew is working with a team of archaeologists to uncover part of the immense royal burial center at Abydos, located 260 miles up the Nile from Cairo. As a line of workers use hoe-like *tureyas* to scrape away the sand, the so-named bucket boys haul away clanking pails of dirt and pour it like water into the laps of sifters. Excavators are on the ground with trowels in hand, surveyors are plotting the coordinates of artifacts, a photographer is documenting each new find, and illustrators are pencil-drawing an ancient coffin and an infant skeleton.

Kneeling on one knee in the center of this swarm is Matthew Adams, associate director of a multiyear project sponsored by the University of Pennsylvania Museum, Yale University, and New York University's Institute of Fine Arts. Adams is brushing sand away to reveal a smooth, ancient mud floor. "If this is from the time of Aha," he says in a raspy voice dried out from months in the desert, "then it's the oldest funerary enclosure ever found in Egypt. We're talking about the beginning of Egyptian history. Not one trowel has been laid here before now."

Abydos is the source of many of Egypt's most ancient artifacts. In 1988 Günter Dreyer, a German archaeologist, unearthed small bone and ivory tags intricately inscribed with one of the world's earliest forms of writing—crude hieroglyphs developed at about the same time as Mesopotamian cuneiform. In 1991 Adams's mentor and the project's director, David O'Connor, uncovered an eerie fleet of wooden boats buried in enormous brick-lined graves.

Now O'Connor and Adams are digging down into the beginning of Egypt's 1st dynasty, a pivotal period when kings laid down the roots of religion, government, and architecture that would last for the next 3,000 years. Unlike the colossal pyramids of later pharaohs, the more modest burial complexes of the Abydos kings consisted of two separate structures—a tomb and a ceremonial enclosure. The large, walled enclosures where mortuary rituals were performed were situated on the edge of town, while the underground tombs were located more than a mile away on the threshold of the desolate Western Desert, a place known to ancient Egyptians as the land of the dead.

All of the 1st-dynasty tombs and most of the enclosures excavated so far are accompanied by subsidiary graves—hundreds in some cases—containing the remains of elite officials and courtiers. Egyptologists have long speculated that these graves might hold victims of sacrifice but also acknowledged that they could simply be graves reserved for the king's staff, ready to use as each person died naturally.

The question of whether ancient Egyptians practiced human sacrifice has intrigued archaeologists since the late 1800s. Frenchman Émile Amélineau and his English rival Sir Flinders Petrie excavated all the 1st-dynasty desert tombs by 1902. Each had been heavily looted in antiquity, and no royal remains were found except a single bejeweled arm. Still, there was much yet to discover. In Aha's tomb were the remains of dozens of wine vessels, tools, some jewelry, and signs of food. Beside the tomb Petrie discovered 35 subsidiary graves, which he called the Great Cemetery of the Domestics. While he didn't dwell on it in his published papers, he hinted at human sacrifice. Later, in the 1980s, German archaeologists uncovered the remains of at least seven young lions.

The only funerary enclosure standing during Petrie's time was the massive 4,600-year-old Shunet el-Zebib, built by the 2nd-dynasty king Khasekhemwy. The towering *shuneh* (storehouse), with its three-story walls enclosing nearly two acres of space, still dominates the landscape. Two of Petrie's associates discovered another 2nd-dynasty enclosure, built by King Peribsen, and Petrie returned in the 1920s and found hundreds of subsidiary graves. The graves surrounded three 1st-dynasty enclosures, but curiously, Petrie located only one of them. These discoveries led archaeologists to speculate that they had found only half the puzzle of Abydos, and that for each tomb they had uncovered out in the desert, there should be a corresponding enclosure still hidden on the city's edge.

In 1967 David O'Connor came to Abydos to search for, among other things, the funerary enclosures that had eluded Petrie. Almost 20 years later, while digging in the shadow of the shuneh, he made a totally unexpected discovery.

"I opened an excavation pit, and poking into one corner of it was this intrusion," O'Connor recalls. "I knew it was something from the earliest dynasty, I just didn't know what." To O'Connor's amazement, the "intrusion" turned out to be one of 14 ancient boats, each buried in its own brick-lined tomb adjacent to the enclosure of a still unknown king. The boats, which measured up to 75 feet long, were expertly crafted and had been fully functional when buried. They proved to be the world's oldest surviving boats built of planks (as opposed to those made of reeds or hollowed-out logs).

"The boats are like the servants who were buried at Abydos," says O'Connor. "The king intended to use them in the afterlife in the same manner that he used them before his death." In life the boats enabled the king to travel rapidly up and down the Nile in a powerful display of wealth and military might. As the Egyptian kings also expected to be kings in the afterlife, the boats would be useful tools.

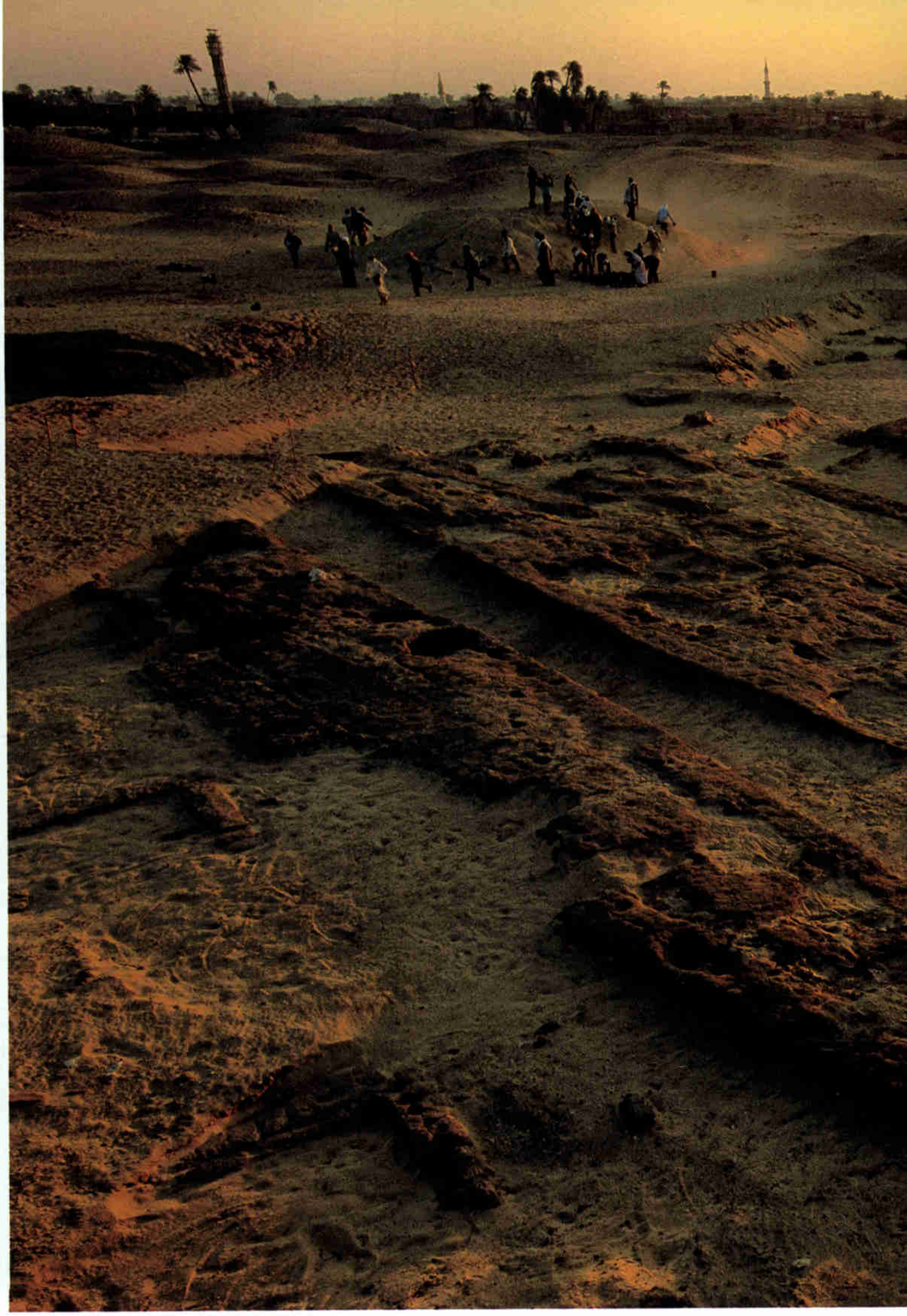
NEWS OF THE BOATS' discovery rippled through the Egyptology world and also energized O'Connor's hunt for the lost enclosures of the first kings. To help focus the search, O'Connor and Adams sought out Tomasz Herbich, a Polish archaeologist who specializes in

Ready for service in the next life, sacrificed donkeys line up in a grave outside the enclosure of a king whose name is still unknown. A total of ten donkey skeletons were uncovered, all bearing signs of age and hard work. Perhaps they had labored for the court of the deceased ruler.

finding buried ruins with a device called a fluxgate gradiometer, a type of magnetometer. It measures slight variations in the Earth's magnetic field caused by certain types of iron oxides beneath the surface. "These oxides are present in Nile mud," explains Herbich. "And what's the main material used by ancient Egyptian builders? Sun-dried bricks made of Nile mud!"

For nearly a week in 2001 Herbich's assistant walked more than ten miles a day over a numbing grid, taking over 80,000 measurements. The survey turned up several small funerary chapels but no enclosures. Then, during Herbich's last hour in the field, his magnetic divining rod finally found royal mud. He downloaded the data onto his laptop, and as the digital map came into focus, he called out, "We have an enclosure!"

Adams and a small crew went to work uncovering part of the enclosure, but the field season was ending, and they had to rebury it and return home. In 2002 O'Connor again asked Adams to go to Abydos, this time to undertake a massive excavation of the new discovery. After a month of *(Continued on page 120)*



AFLOAT IN THE DESERT

Arranged like a fleet moored at a wharf, mud-brick graves hold 5,000-year-old planked boats—the oldest ever found. Awaiting royal command, the vessels were likely meant to transport supplies to the next world and to enable the king to tour his realm in death as he had in life.

LAUNCHING ETERNAL ICONS

As workers toil in the desert sun, a boat cemetery takes shape in the shadow of a 1st-dynasty king's enclosure (right). Fourteen vessels, some as long as 75 feet, are eased into graves and covered with mud bricks and plaster. "Huge wooden boats, brought to this desert location, make quite a statement of royal power and prestige," says Matthew Adams, associate director of the team

now studying the boats' fragile remains. In a field lab (top left) Adams examines planks salvaged from one of the boats. Though heavily damaged by insects, the wood reveals the earliest known example of a construction technique that

ART BY RICHARD SCHLECHT, NGM ART (BELOW)

appears later in Egypt: Ropes passing through slots in long planks bound the hull together, and plant matter stuffed in the seams prevented leaks.

The boats also offer insights into religion. Their connection with the king's afterlife shows the early importance of boat symbolism—a key element in religious imagery for the next 3,000 years. A relief in the 19th-dynasty temple of Seti I at Abydos (left) shows a ritual boat linked to the goddess Isis, wife of Osiris.

tediously peeling back layers of sand, Adams uncovered jars and wine stoppers bearing Aha's name, confirming that his lost funerary enclosure was at last found.

Once the crew reached the enclosure's floor, they discovered six surrounding graves. Three contained the bodies of adult women, one held the remains of a man, and one held a young child with 25 ivory bracelets embellished with tiny lapis beads. The sixth grave remains unexcavated. In each case the archaeological evidence pointed to a sacrificial death.

"The graves were dug and lined with bricks, then roofed with wood and capped with mud-brick masonry," says Adams. "Above that masonry cap, a plaster floor extends out from the enclosure and covers all the graves." The floor extension is seamless—an important clue, for it would have been impossible to entomb people under the floor except all at the same time.

It's unlikely that 41 people—the six at Aha's enclosure plus 35 at his tomb—would have died of natural causes at the same time. Another possibility is that they died randomly over time and were then stockpiled and reburied en masse. But for O'Connor and Adams, the evidence strongly suggests they were sacrificed.

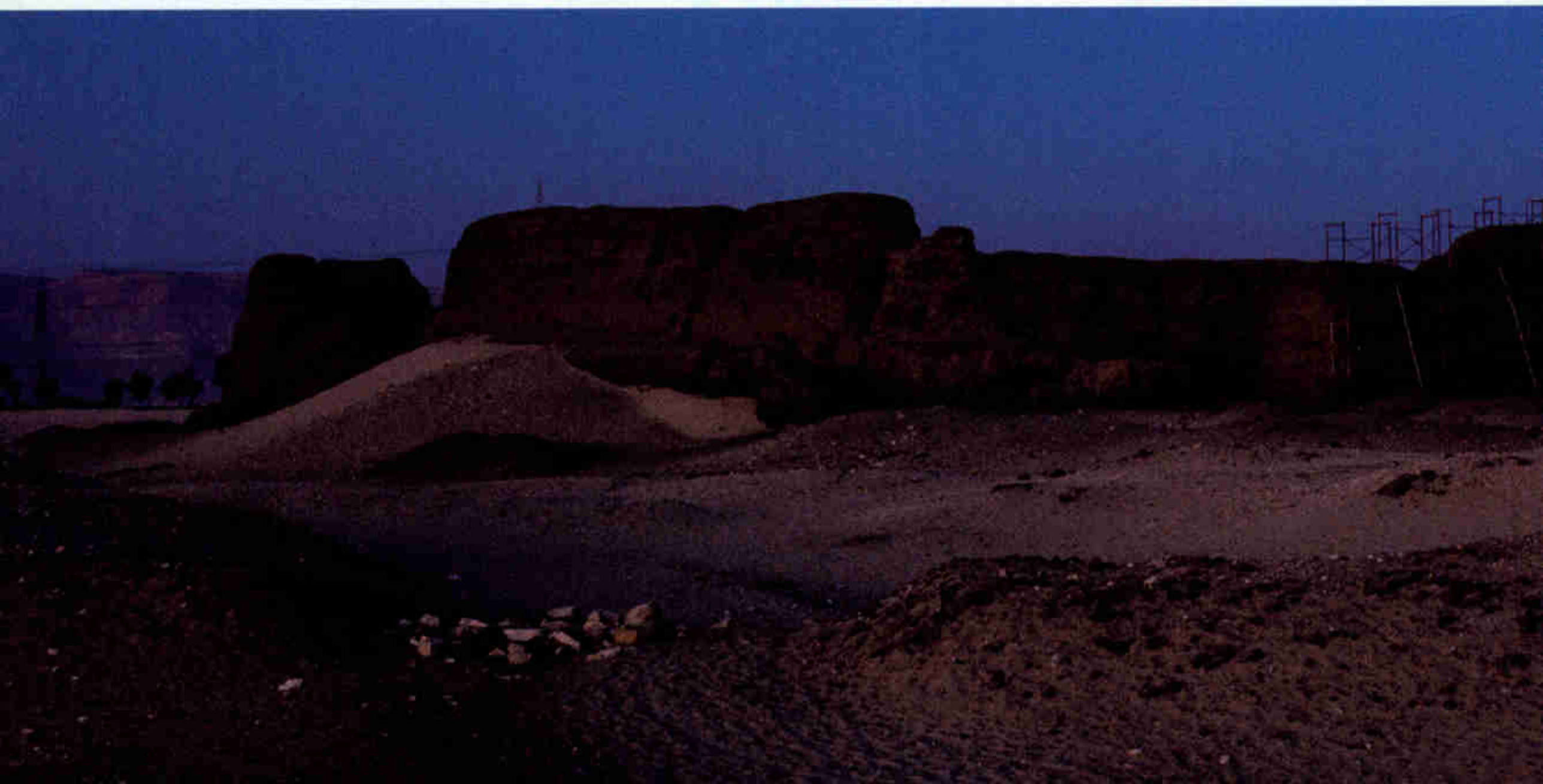
How were they killed? Petrie believed that he saw signs of post-burial movement in the tomb graves, suggesting that people were alive or semiconscious when buried. Brenda Baker, a physical anthropologist from Arizona State University, examined all the skeletons from Aha's enclosure and found no signs of trauma. "The method of their demise is still a mystery," says Adams. "My guess is that they were drugged."

Or strangled, suggests Nancy Lovell, a physical anthropologist at the University of Alberta. Lovell studied skulls from Aha's tomb and found telltale stains inside the victims' teeth. "When someone is strangled," she explains, "increased blood pressure can cause blood cells inside the teeth to rupture and stain the dentin, the part of the tooth just under the enamel."

It now seems clear that human sacrifice was practiced in early Egypt—as was true in other parts of the ancient world. Sir Leonard Woolley's excavation during the 1920s and '30s at Ur in modern-day Iraq revealed hundreds of sacrificial graves dating back to 2500 B.C. and related to the burial of Mesopotamian kings and queens. Evidence for sacrifice has also been seen in Nubian, Mesoamerican, and several other ancient cultures.

In Egypt enthusiasm for the grim practice seems to have waned quickly. Aha's subsidiary graves are the earliest to be found, and his successor, Djer, embraced the practice with fervor—more than 300 graves flank his tomb, and another 269 surround his mortuary enclosure. But Qaa, the last ruler of the 1st dynasty, had fewer than 30 sacrificial graves beside his tomb,

Still standing after almost five millennia, King Khasekhemwy's enclosure, the Shunet el-Zebib, marks the end of an era. Luxuries such as stone jars (opposite) surrounded the ruler in his mud-brick tomb. But his successors were buried elsewhere, under soaring pyramids of stone.



although his enclosure remains lost. And by the 2nd dynasty the practice simply stopped.

O'Connor thinks it ended because the royal staff rebelled. "People tend to say that the Egyptians were becoming more civilized and that's why it stopped, but I think that reflects our own prejudices. These graves included relatively high-ranking people, and the reason it stopped might be more political than ethical." Perhaps it was an honor to serve the king in the afterlife, but it was an honor that could wait.

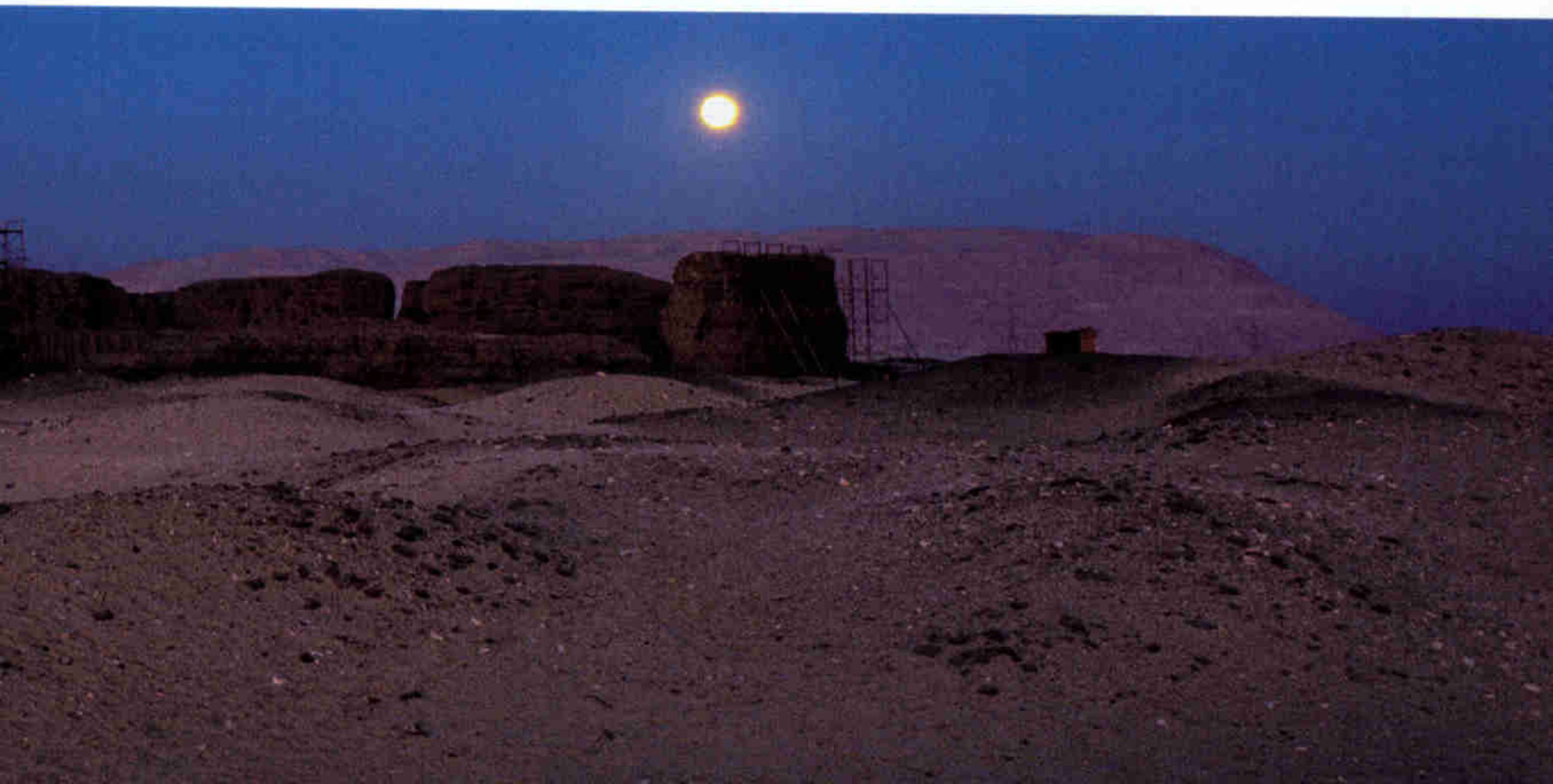
KENNETH GARRETT, EGYPTIAN MUSEUM, CAIRO

By the 3rd dynasty Egypt's pharaohs began building their tombs more than 250 miles downstream at Saqqara. There, a new tradition arose: The separate tomb and enclosure were combined into a single complex that included a colossal pyramid tomb bounded by the walls of a ceremonial enclosure. The royal necropolis at Abydos lay abandoned for the next 700 years.

Then during the Middle Kingdom the cult of Osiris became a major force in Egyptian religion. Legend held that Osiris, lord of the afterlife, was also Egypt's first king, and so pharaohs dispatched priests to Abydos on a kind of archaeological expedition to locate Osiris's tomb. They excavated several of the 1st-dynasty tombs and ultimately decided that Djer's belonged to Osiris. In so doing they turned Abydos into the mecca of ancient Egypt. Over the next 2,000 years several pharaohs, including Senusret III and Ramses II, built great monuments and temples at Abydos to honor Osiris. Hundreds of thousands of Egyptians, farmers and pharaohs alike, made the pilgrimage to take part in an annual celebration of Osiris's resurrection. The festival culminated in an elaborate parade that wound from the town past a series of small chapels built to honor the god-king, then up a dry riverbed to the ancient desert cemetery.

Arriving at Osiris's tomb, the pilgrims had no inkling that hundreds of their ancestors—royal staff members sacrificed more than a thousand years earlier—lay buried beneath their feet. Seeking Osiris's blessing for their own passage to the afterlife, the worshippers brought millions of small clay offering pots filled with fruit and smoldering incense. You can still see the potsherds today, piled high like so many hopes that in the wake of death comes eternal life. □

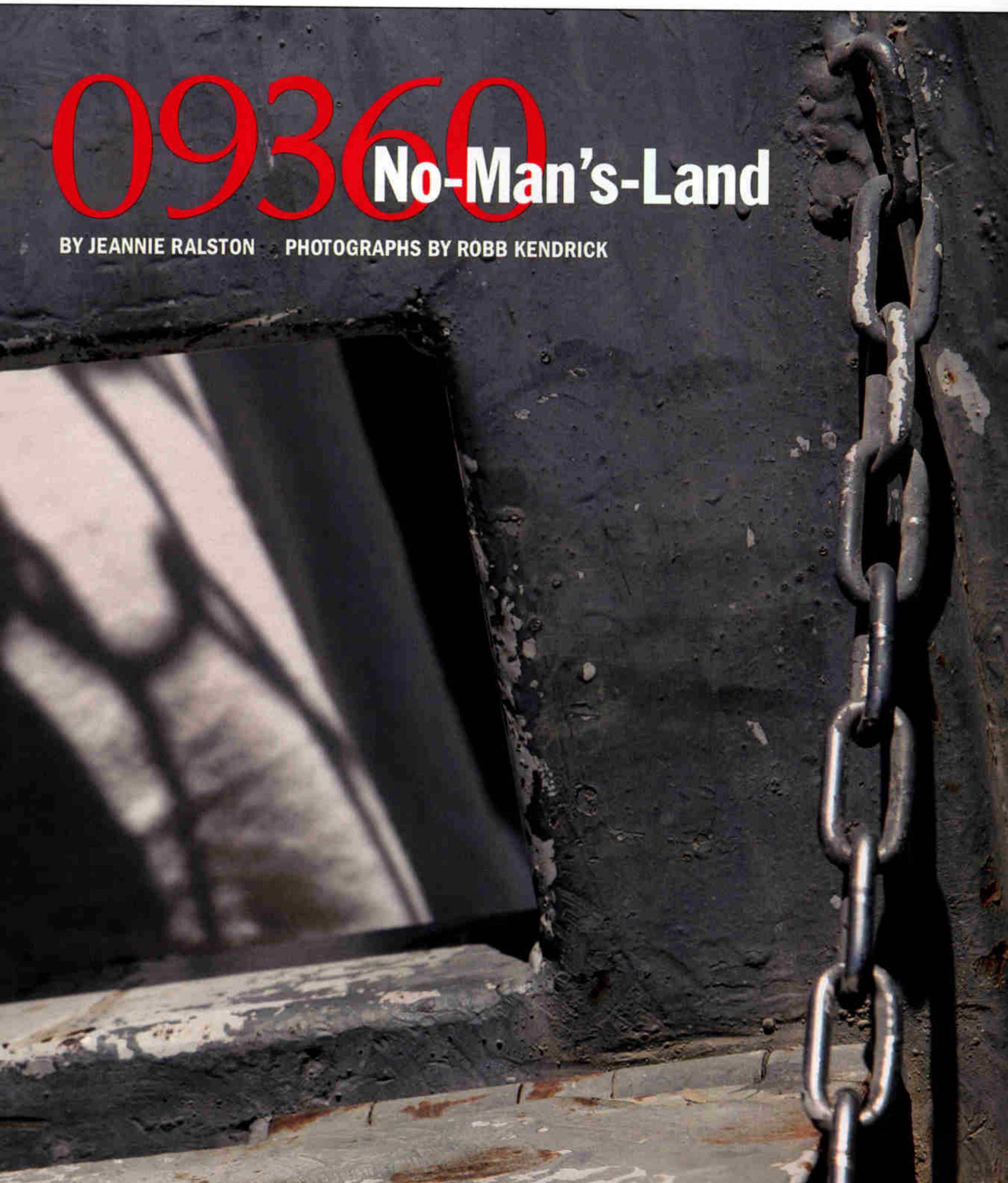
RAIDERS OF THE LOST ARM? Learn about the rough-and-ready days of early archaeology at Abydos, including the strange story of a jewel-bedecked arm discovered in a royal tomb, at **nationalgeographic.com/magazine/0504.**



GUANTANAMO BAY, CUBA

09360 No-Man's-Land

BY JEANNIE RALSTON PHOTOGRAPHS BY ROBB KENDRICK



Since early 2002 suspected terrorists have remained in limbo at the U.S. naval base at Guantanamo Bay—a barren corner of Cuba that the U.S. has leased for the past century. Controversy over treatment of the 550 detainees continues as military and civilian courts sort out their fate. These photographs offer a look into the lives of both prisoners and staff in the secretive outpost, where prayer beads count among a prisoner's few personal items.

GUANTANAMO BAY, CUBA

Locked Up Their faces digitally obscured to meet security requirements, detainees share lunch in a cellblock corridor. These men have earned the privilege of eating together and wearing white clothes (instead of orange uniforms) by cooperating with U.S. interrogators. Those who resist receive harsher treatment; internal FBI memos document abusive practices.

At Liberty Taking a break from the mess hall, U.S. soldiers enjoy a typical Cuban meal cooked by one of their own: Sgt. Mirelys Carvajal, seated at the head of the table. Born in Cuba, Carvajal fled to the U.S. in 1985 with her mother and sister. She volunteered for temporary duty at Guantanamo in order to see her homeland again. Sixty Cubans—defectors who fled to the base, and their families—now live here permanently.

Bristling with razor wire and searchlights, a maze of fences surrounds the detention center, known as Camp Delta. "It's unbelievably regimented," says photographer Robb Kendrick. "There are gates within gates within gates." He was not allowed to show two guard towers in the same picture, a security measure to prevent mapping of the perimeter.

The night before I left for one of the most controversial spots on the planet, the movie *A Few Good Men* was on television. "I eat breakfast 300 yards from 4,000 Cubans who are trained to kill me," Jack Nicholson's Marine colonel snarled at Demi Moore. The chilling monologue underscored how very much has changed at the U.S. naval base at Guantanamo Bay. When the movie came out in 1992, Guantanamo was famous as the only American base in a communist country. Today, with no threat from the Red Menace, Guantanamo gets its notoriety from 550 detainees—allegedly members of al Qaeda or the Taliban—who arrived in early 2002. The original plan was to interrogate the men and prosecute the worst before military tribunals, yet three years later few have been brought to trial. Critics question the decision to classify the detainees as enemy combatants rather than prisoners of war, which exempts them from the provisions of the Geneva Conventions—allowing for more coercive interrogations and indefinite detention. Once a relic of the Cold War, Guantanamo has suddenly become, in the words of its commander, Capt. Les McCoy, "the most highly visible U.S. base in the world."

Under scrutiny, perhaps, but hardly visible. Media access to the base has been tightly controlled. When photographer Robb Kendrick and I secured permission to visit Guantanamo with a group of reporters, we knew we would only be allowed to see what the government wanted us to see.

Lying in the rain shadow of the Sagua-Baracoa mountains, the terrain surrounding the bay is as brown as cardboard and nearly treeless. "Tucson by the sea" is how the U.S. soldier sitting next to me on the charter plane described it as we arrived. Along the eastern shore lies the main part of the naval base—a sprawl of offices, barracks, storehouses, and a tiny

SIZE OF NAVAL BASE:
45 sq mi, land and water
OPERATING COST:
162 million dollars a year
BASE POPULATION IN 2000: 2,800 **2004:** 9,500
DETENTION CAPACITY:
1,200 inmates
TOTAL NUMBER OF DETAINEES HELD SINCE JANUARY 2002: 750
NATIONALITIES AMONG DETAINEES: 41
INTERROGATION HOURS:
Around the clock
REPORTED SUICIDE ATTEMPTS: 34

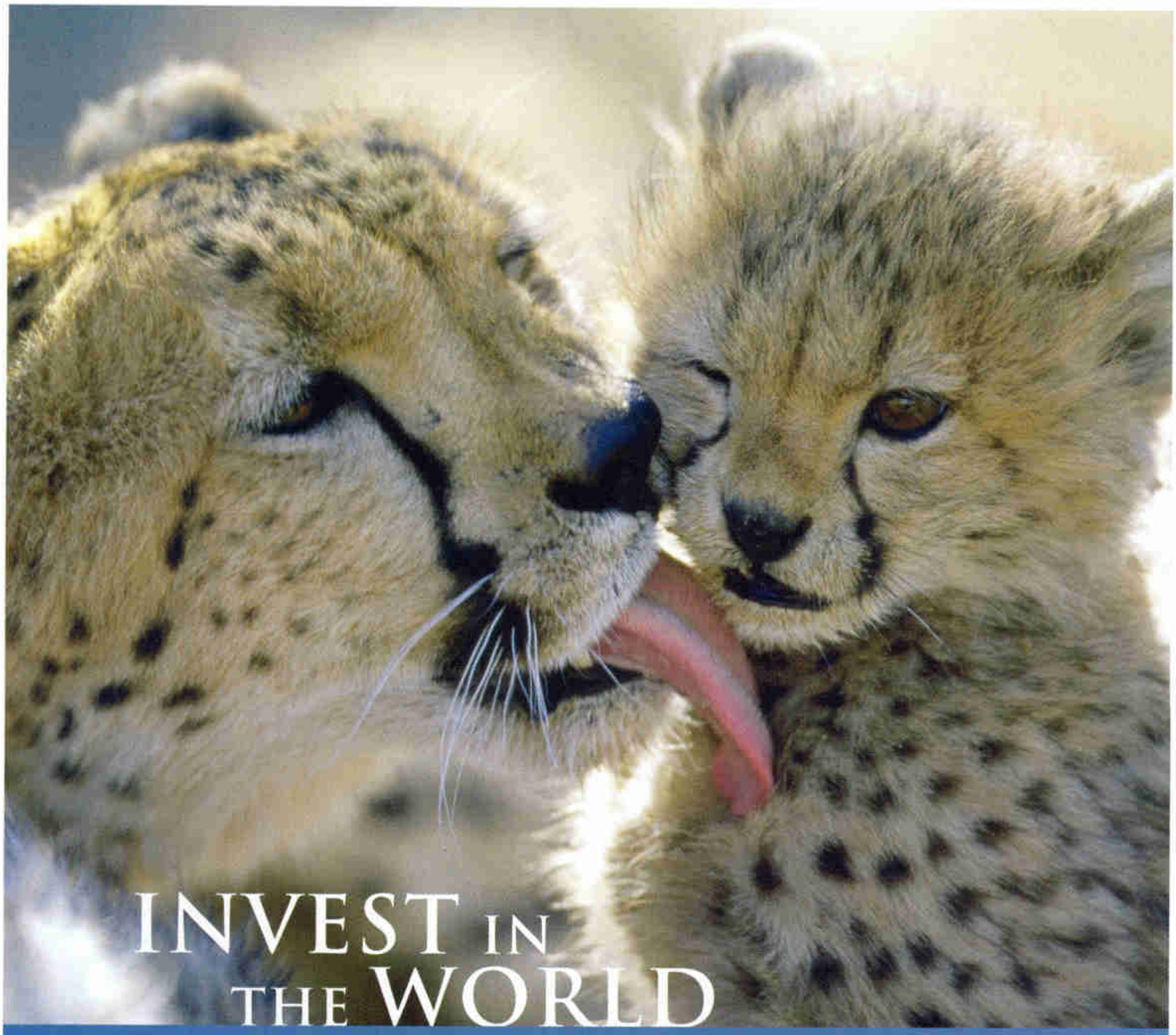


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photo: Howard G. Buffett

"downtown" where soldiers go to shop, watch a movie, or eat at one of nine restaurants. A narrow ridge separates the main area from Camp Delta, a series of prisons facing the ocean. Nearby is Camp America, where the soldiers live in metal warehouses partitioned off with shower curtains into "hooches"—cubicles little bigger than a queen-size bed.

Troops here say they are serving a role as important, if not as dangerous, as the one being played by soldiers in Iraq. Yet they describe life in Camp America as painfully dull. "It's like *Groundhog Day*—the same day over and over," says Sgt. 1st Class Steve Segin, a National Guardsman. Many seek diversion by scuba diving or tucking swatches of Astroturf into their golf bags so they can tee off on a grassless course.

Guantanamo might not rate as a tourist spot, but it's proved the ideal place for keeping the detainees in legal limbo. Not wholly American, not wholly Cuban, the naval base operates under a lease that dates back to 1903. After Fidel Castro came to power in 1959, the U.S. military encircled the base with a 17-mile fence topped with barbed wire and dotted with sentry towers and planted some 60,000 land mines. Today marines still speak lock-jawed so Cuban soldiers watching them through binoculars can't read their lips. One marine I met keeps a dog tag around his neck and another in his boots in case his lower body gets separated from his upper body. Yet such vigilance seems to be mostly habit. The U.S. dug up the minefield in the late 1990s, and Captain McCoy meets with his Cuban counterpart to discuss such banalities as joint fire drills.

Now there is a new enemy. At Camp Delta detainees are sorted into different security levels. Under a reward system established in 2003, those who cooperate are transferred to a medium security facility where they wear white clothing instead of orange uniforms and share sleeping quarters and meals with other detainees. They may spend nine hours a day outside, play soccer and chess, and watch movies. The majority, however, lead a bleaker existence, housed in a maximum security facility and allowed only 30 minutes outside every other day. On a tour of this area, we walked through a cellblock reminiscent of a dog pound. In outdoor pens, one detainee kicked a soccer ball against the fence, another sat for

Bare essentials await a new arrival in a cell measuring eight feet by six feet eight inches: an orange uniform, flip-flops, linens, toiletries, a prayer cap, prayer beads, and a copy of the Koran. When not in his cell or outside exercising, a detainee spends hours in an interrogation room responding to questions from the CIA, the FBI, the Pentagon, or other agencies dealing with U.S. security. Interrogations begin with the detainee shackled to a bolt in the floor.

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SPORT COURT

a haircut, while a third shouted in Arabic to the guy in the next pen. The most dangerous are kept in a 19-million-dollar super-max security unit.

The U.S. government asserts the detainees receive first-rate medical care and that food is prepared to meet Muslim dictates. "Some say they've never eaten so well," says Chief Warrant Officer Thelma Grannison, who headed the cafeteria. "A lot have gained weight." But many detainees have succumbed to depression—and some have attempted suicide—not knowing when, or if, they will ever be free. During my visit an officer and a translator read a statement to each detainee through a cell door describing the Supreme Court's decision last June to allow them to challenge their detention in U.S. courts. Before I could gauge their reactions, we were hustled away and told a detainee was about to make a scene.

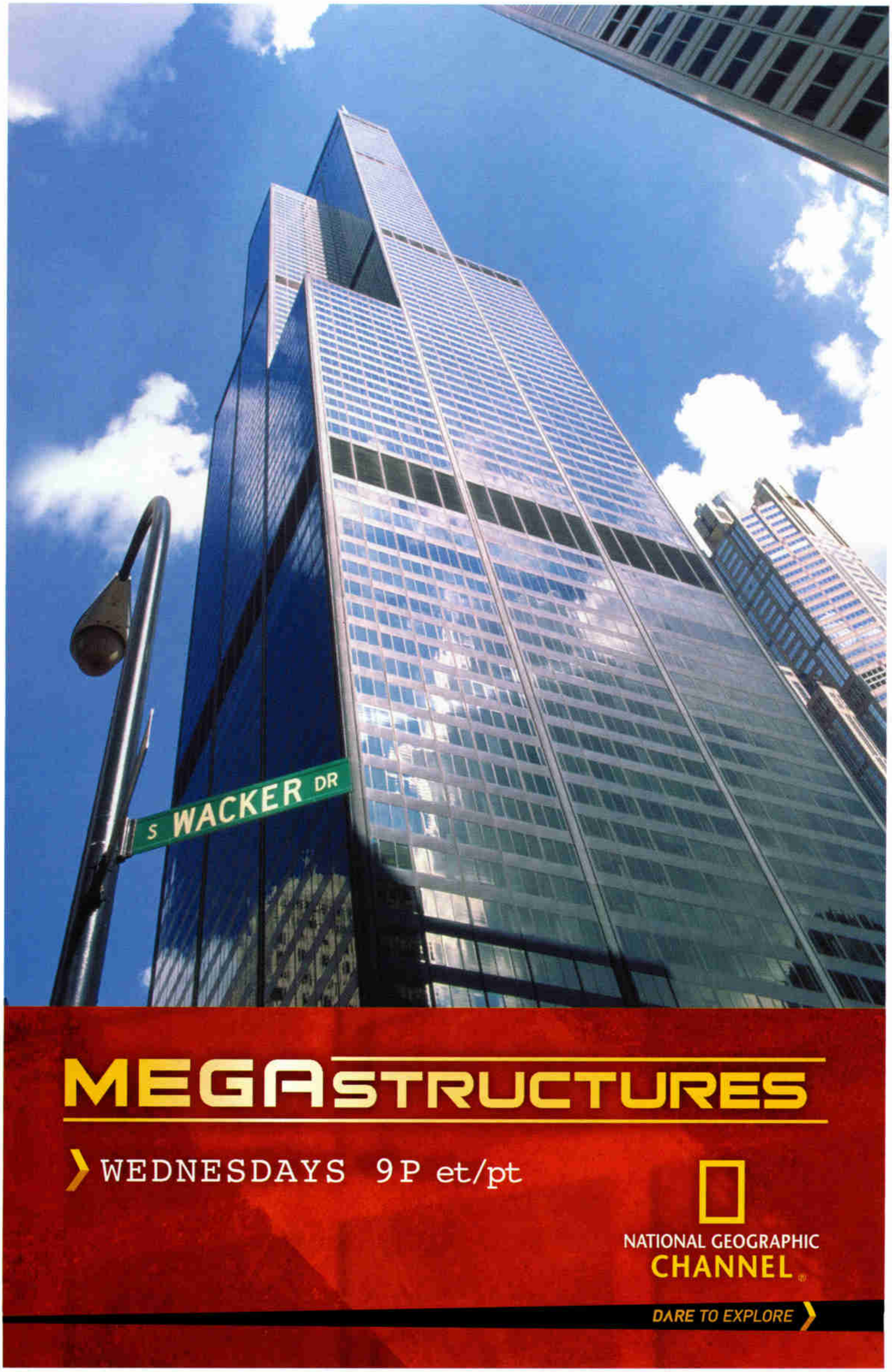
Several released detainees have alleged abusive interrogation methods such as beatings, humiliation, and sleep deprivation—charges supported by an International Committee of the Red Cross report, as well as by recently released internal government documents. The U.S. military says any wrongdoing will be investigated. "We get painted with the same brush as Abu Ghraib," Brig. Gen. Martin Lucenti, Sr., told me as a waiter at the Bayview Club restaurant filled our wineglasses. "We are not Abu Ghraib."

I came away from Guantanamo with the sense that the clarity that stirred the pulse of the soldiers during the Cold War was gone. Even though the war on terror has revitalized the base's purpose, the mood was strangely lethargic. The detainees are in limbo, and the soldiers are too—serving their time but yearning to get back to their lives. Even the fate of Guantanamo itself is up in the air, since it may no longer make sense to keep detainees at a base so far from U.S. courts.

"Right now everything is under review," said press officer Lt. Col. Leon Sumpter. In this gritty place—shaped by decades of fending off an enemy right outside its fence—such uncertainty may be the hardest burden to bear. □

CUBA CONTROVERSY Join our forum and share your thoughts on the detention of suspected terrorists at Guantanamo at **nationalgeographic.com/magazine/0504.**

Exercise is a solitary activity for an inmate (above) whose vivid uniform marks him as uncooperative. He gets 30 minutes three times a week, followed by a shower. On the opposite side of the base, staff gather in an open-air theater to watch a first-run movie. With a golf course, a shopping mall, and a McDonald's, Guantanamo almost seems like any small town with a maximum security prison—but there's no escaping the role it plays in a world increasingly on edge.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(1959 – 2004)

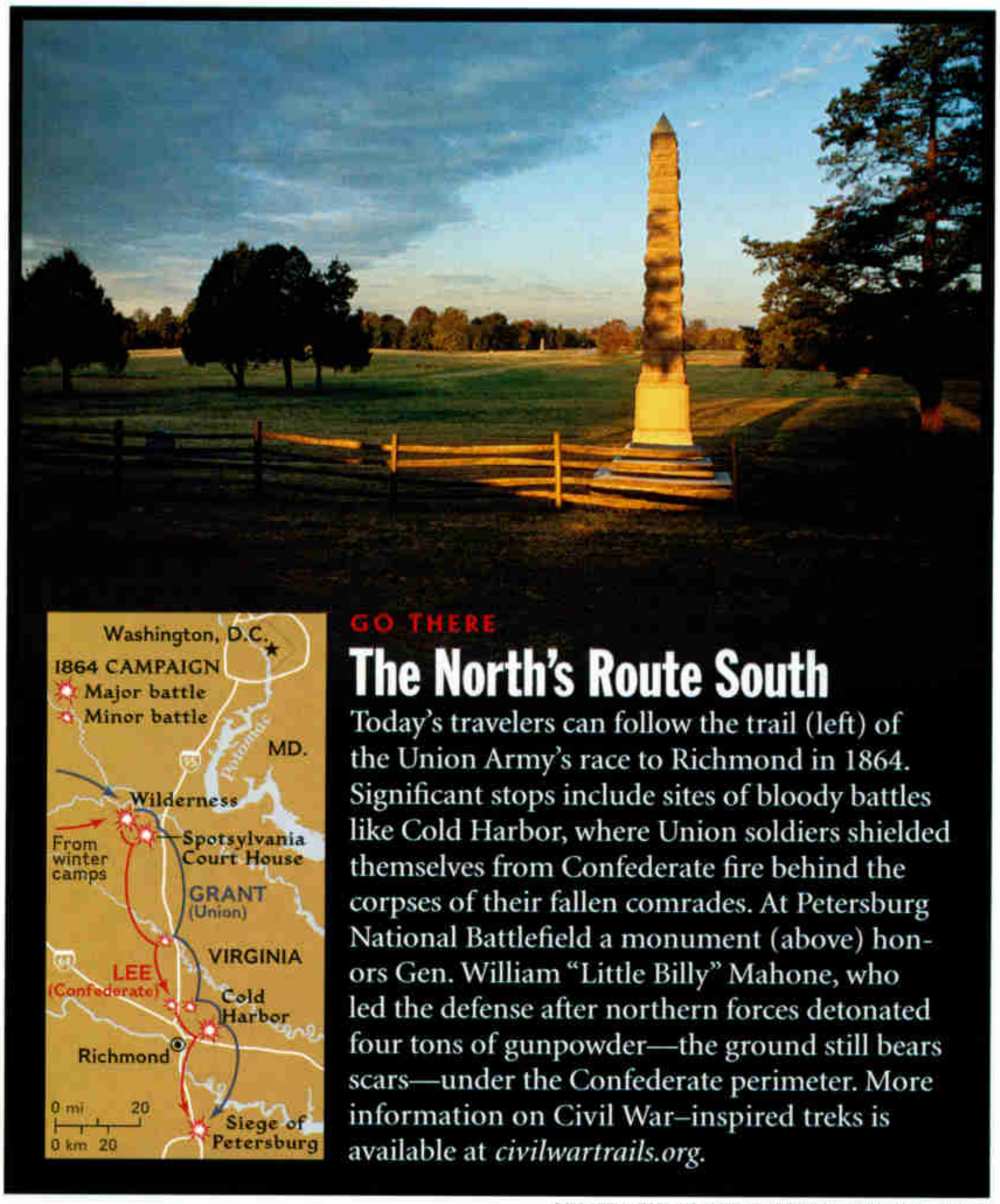
Nicolas Reynard

"Nicolas loved this picture," says illustrations editor Elizabeth Krist, who worked with Reynard on this issue's Moken story. For him this shot of a child was "pure joy, captured on film," she says. "For me it captures the spirit of Nicolas." The French photographer, who died in a plane crash last November, spent his adult life in a state of boundless delight, frequently documenting the world's vanishing cultures with a camera and an understanding heart. He especially admired the tribes of Brazil and wanted to share his passion with his six-year-old daughter, a city girl from Paris. The two spent a month living with the Kamayurá Indians in the rain forest so that she might see the world as Nicolas did, beautiful and whole. He wished that for us all.

MARIA R. MENDES BITTENCOURT

Do It Yourself

CIVIL WAR BATTLEFIELDS (SEE PAGE 62)



GO THERE

The North's Route South

Today's travelers can follow the trail (left) of the Union Army's race to Richmond in 1864. Significant stops include sites of bloody battles like Cold Harbor, where Union soldiers shielded themselves from Confederate fire behind the corpses of their fallen comrades. At Petersburg National Battlefield a monument (above) honors Gen. William "Little Billy" Mahone, who led the defense after northern forces detonated four tons of gunpowder—the ground still bears scars—under the Confederate perimeter. More information on Civil War–inspired treks is available at *civilwartrails.org*.

SAM ABELL (TOP); NG MAPS; C. HARRISON CONROY CO. (BELOW)

TRY IT AT HOME

Were Your Ancestors Soldiers?

Ever wonder whether a family member wore the blue or gray?

The National Park Service's Civil War Soldiers and Sailors System database lists more than four million Union and two million Confederate soldiers' records at *www.itd.nps.gov/cwss*. The sailors' database is still in the works but already includes some 18,000 men (and a dozen women) of African descent who served in the U.S. Navy.

Individual records for many Union and some Confederate soldiers are at the National Archives. Go to *archives.gov/research_room/vetrecs*.

WEBSITE EXCLUSIVE Take a virtual Civil War battlefield tour with photographer Michael Melford at **nationalgeographic.com/magazine/0504**.

PICKS

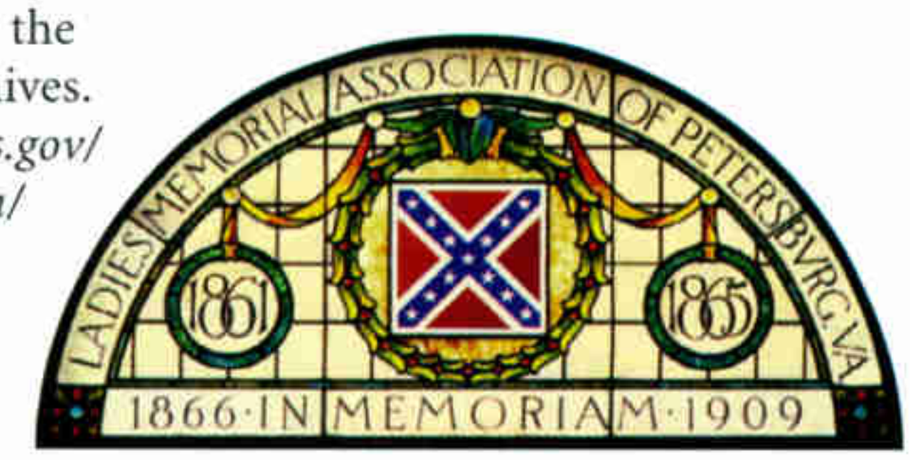
3 arts of war

Artwork helped inform during the Civil War—and commemorate the brave when it was over.

■ **Photography** from the era is most often associated with Mathew Brady and Alexander Gardner, but they also supervised other photographers traveling with Union troops. Work they processed in wagon darkrooms (much of it credited to Brady) is today owned by the Library of Congress. More than 7,000 images are online at *lcweb2.loc.gov/pp*.

■ **Drawings** by reporter-artists such as Winslow Homer—who covered Petersburg for *Harper's Weekly*—offered glimpses of the front. Learn more in Julian Grossman's *Civil War Battlefields and Campgrounds in the Art of Winslow Homer* (Abradale/Abrams, 1991).

■ **Stained glass windows** (below) by Louis Comfort Tiffany at Petersburg's Old Blandford Church honor war dead from each state of the Confederacy.



Flashback

AMERICAN PRESS ASSOCIATION

CIVIL WAR BATTLEFIELDS

Powder Buffs

In the 1860s the U.S. Civil War depleted the American male labor force at the same time it increased the need for weapons. So girls and women began staffing munitions factories in both the North and South. They wouldn't be the first, or the last, females to take advantage of a wartime job boom.

During World War I, in just one factory in France, 4,000 women were "employed 24 hours of each day grinding and filling high-explosive shells," noted an article in the April 1917 GEOGRAPHIC, where this image of French workers ran. "This war," another photo's caption claimed, "has given women their opportunity." —*Margaret G. Zackowitz*

WEBSITE EXCLUSIVE

You can access the Flashback photo archives and send electronic greeting cards at **nationalgeographic.com/magazine/0504.**

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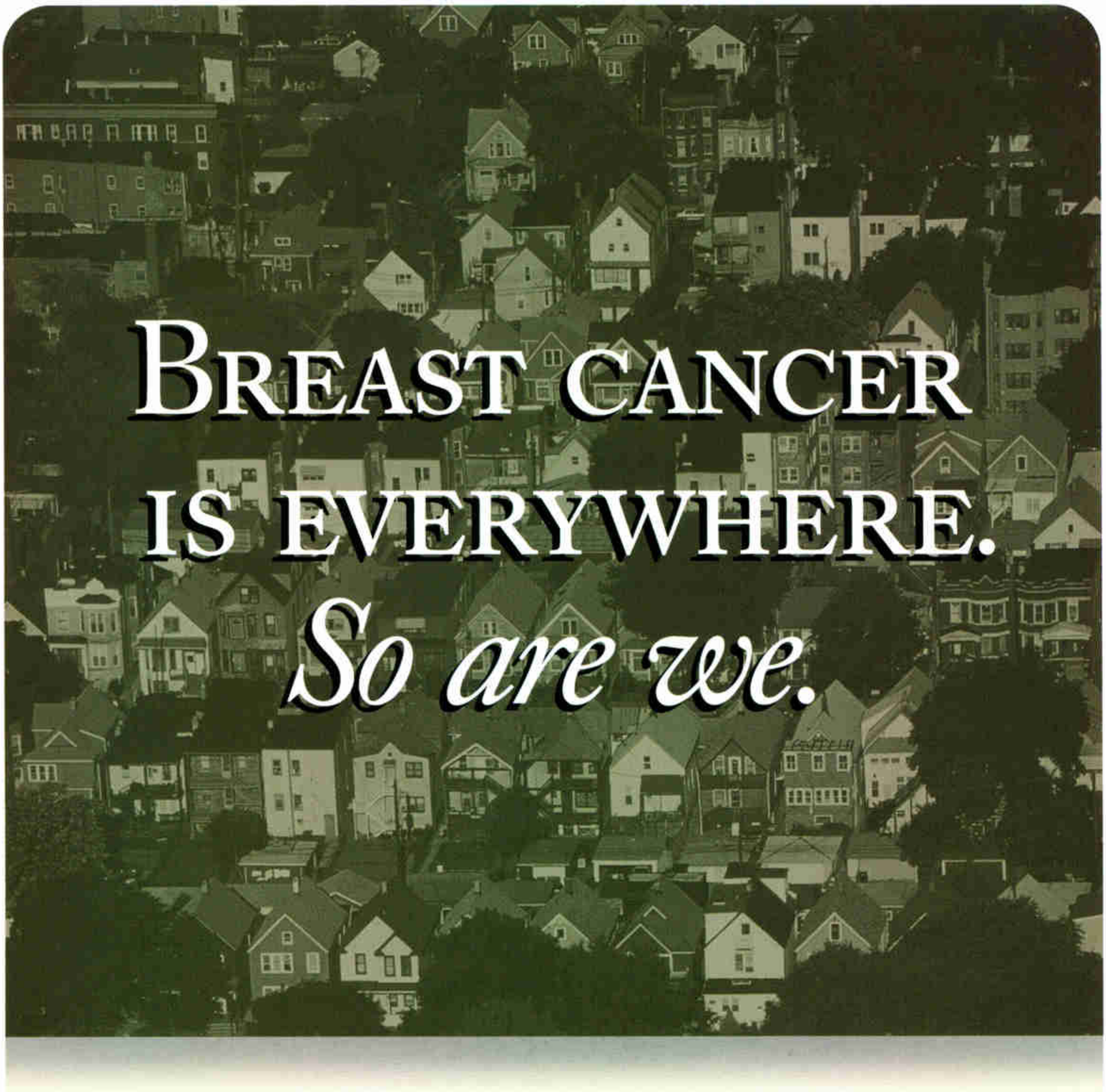

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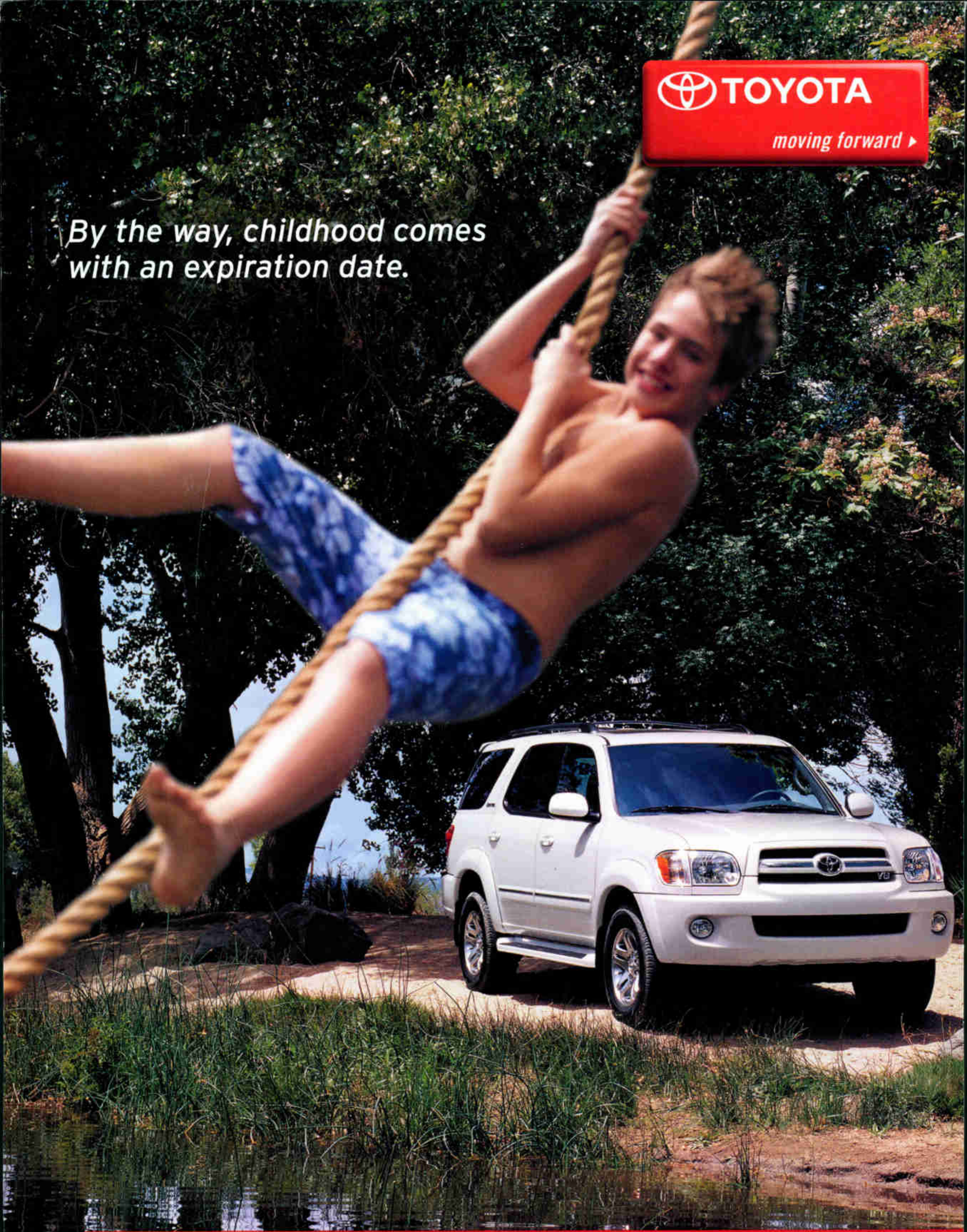

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